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A RAILWAY ENGINEER'S PREDICAMENT IN INDIA.

"A PERMANENT way inspector on the Dacca Mymensing Railway," says Mr. G. Mills, of Duntesborne House, Cirencester, to whom we are indebted for our sketch, "was one day trolleying over his length, when he suddenly saw four tigers in front of him on the line, at the bottom of a steep decline. The native trolley men let go the trolley and left Kelly, the permanent way inspector, to his fate. Kelly applied the brake and in vain tried to stop. On his approach, however, the tigers walked slowly into the jungle. Kelly, still pale with fright, told me this story on the day of its occurrence. Afterward, whenever I met him on his

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trolley, he was always armed with an ancient-looking gun. The place where this occurred was Mile Thirty-four, in the middle of the Madapur Forest, and I knew that there were tigers and cubs at the place, because their footprints could be seen almost daily in the side trenches of the railway cutting. The Dacca Railway runs for twenty miles through a dense sal forest, which is inhabited by very few people, and is infested with tigers, bears, sambur, pig, and hog deer. During the construction of the railway I was in charge of this length, and enjoyed many a good day's sport."—*The Graphic.*

EFFECT OF OIL ON DISTURBED WATER.

By RICHARD BEYNON.

GENERALLY speaking, proverbs are the resultant expression of observed facts, but the efficacy of oil upon troubled waters would appear to be a proverb which, instead of being preceded by and founded upon tria, and experiment, has rather led to the scientific demonstration and establishment of the truth it asserts. From the very earliest ages the effect of oil when poured upon disturbed water appears to have been widely known. Aristotle mentions it, and accounts for the phenomenon by assuming that the thin film of oleaginous matter into which oil resolves itself when poured upon water prevents the wind from obtaining a hold upon the water, and so checks the wave formations which are the usual result of wind at sea. Pliny, too, observes that among the officers of his fleet the soothing influence of oil was matter of common knowledge, and that the Assyrian divers were in the habit of sprinkling the surface water with oil when they wished to smooth down ripples, and so obtain a better light for prosecuting their work below. Coming down to more recent times, the custom of oiling the waves with a view to facilitate navigation would appear to have fallen into desuetude. Benjamin Franklin, however, seems to have been led, from observing the effect of pouring overboard some greasy water, to test its potency in a thoroughly scientific manner, when on a voyage across the Atlantic. Having experimented with great success upon the surface of a pond near London, he tested the effects of oil upon the sea itself. A stormy day was chosen, and from a boat, some half a mile from the beach at Portsmouth, oil was poured upon the sea. The experiment met with a very small share of success, for, while a greasy patch of water was discernible right to the shore, the surf continued to break upon the beach with unabated vigor. Subsequent and recent investigation has confirmed Franklin's finding, and proved that the greatest benefit derived from the use of oil is obtainable in deep water, where wave motion is merely undulatory. When a shore-approaching wave ceases to find enough depth to impart to its neighbor its peculiar undulatory motion, it is no longer a wave pure and simple, but becomes an actual moving body of water, which moves rapidly forward until it breaks with great violence upon the shore; upon such waves as these, oil has little or no effect.

The knowledge of the influence of oil upon a rough sea has long been known to those engaged in the whale and seal fisheries, and its application is of common occurrence. When their vessels or boats are overtaken by a storm, they usually, by means of a drogue or sea anchor, make what is nautically termed a dead drift, *i. e.*, they suffer themselves to be slowly drifted before the wind. In such circumstances as these, the application of oil to the waves insures that the area into which the boat drifts is one of calm, as the oil spreads more rapidly than the boat moves, and consequently prepares a smooth patch for the vessel to drift into. If the captain, however, prefers to run his vessel before the wind, then she ranges ahead of the oiled patch, and thus the effect of oiling the waves is very materially discounted.

The native Eskimo, when engaged in transporting his family from place to place, always insures a smooth passage for the *oomiak*, or women's boat, by trailing a punctured skin filled with oil from the stern of his *kayak*, which he propels at some considerable distance ahead of the boat containing his wife and children.

Within the last twenty years many well authenticated instances have been placed on record as to the potency of oil as a water soother, but unfortunately the value of such reports is very much diminished by the ship masters neglecting to explain the relative position of their vessel in regard to the wind and sea. The British war ship Swiftsure, when on a voyage from Honolulu to Esquimault, encountered a gale accompanied by tremendous seas. A bag, punctured with the point of a knife, was filled with oil and rigged out on the weather side of the vessel. This had such a marked effect that the vessel rode bravely through the gale, and reached her destination in perfect safety. On October 8, 1880, a Mr. Fondacaro left Montevideo for Naples in a three ton boat. He arrived at Malaga on February 4, 1881. On his voyage across the Atlantic, he had repeatedly to lay to during stress of weather, and reports that he considered his safe arrival entirely due to his use of oil. A gallon of olive oil would last him, when hove to, for twenty-four hours. He gives it as his experience that oil does not diminish the size of the waves, but renders them comparatively harmless by preventing their breaking. There is a consensus of opinion among those who have tested the use of oil that a small quantity is quite as efficacious as a larger one, a consumption of one pint per hour being sufficient. Smal. as this quantity is, the extreme expansibility of oil when floating upon the water renders it quite adequate. Thus a ship running 10 knots an hour will leave behind her a wake some 10 knots by 40 feet, covered with a thin film of oil.

The Dunkirk Chamber of Commerce, fully alive to the vast importance of the use of oil as materially conducing to safe navigation, have just reported on the result of some tests made at their direction among the French fishing fleet off Iceland. One master reports that by its use he was enabled to ride out successfully a prolonged and severe spell of bad weather, which compelled his *confreres* to run to port until the weather moderated. The chamber rewarded him with 100 francs. Other captains who have reported in detail the result of their experiments agree with him in stating that, for small vessels experiencing stress of weather in deep water, the use of oil cannot be too highly recommended.

Nor is the utility of oil confined alone to this branch of marine navigation. Advices just received from New York furnish some interesting particulars relative to the towage of the disabled steamship Italia, of the Hamburg American Company. The Italia broke her shaft while proceeding from Havre to New York. In this condition she was taken in tow by the Gellert, of the same company. The towing hawsers—6 inch steel wire—were lengthened by heavy chain cables until the distance between the two vessels was increased to 1,000 feet. Unfortunately, a heavy gale from the northwest caused a dangerous sea to arise, and it was feared that the Italia would have to be abandoned. As a last resort, a can of oil with a small hole in the bottom was set over the stern of the Gellert. The effect, according to the master, Captain Kampf, was magical. The sea broke over the bows of the Italia with much less fury, merely surging past in a heavy swell, while the tension on the cable was immediately relieved, and the Gellert was enabled, in spite of continued bad weather, to reach New York in safety, having towed her charge continuously for the distance of 750 miles. Possibly many cases of abandoned towages in bad weather might be averted did the masters of tugs but try the effect of a little oil prior to casting the vessel adrift.

The true part played by this oleaginous film in diminishing the disturbance of the sea seems to be that of a lubricant. Waves are formed by the friction of wind and water. Any force, therefore, that tends to lessen the friction reduces the violence of the waves. As far as is at present known, animal or the heavier vegetable oils form the best lubricant between the two elements. Mineral or fossil oils, which possess less viscosity and are less oleaginous in their mechanical properties, exert much less influence upon the water. This anti-frictional force of oil can hardly be overestimated. The Atlantic waves have been calculated to exert an average pressure during the winter months of 2,086 pounds per square foot. During a heavy gale this pressure is increased to 6,983 pounds; yet the thin oil blanket is sufficient, when applied under certain conditions, to enable a vessel to navigate through them in perfect safety, their oiled summits raising themselves in sullen grandeur, but never breaking aboard. What the exact coefficient of friction between air in motion and water is, and the proportion of its reduction by oil or other lubricants, are questions that open a most interesting subject of inquiry, the resolution of which will prove highly beneficial to the whole nautical and mercantile world.

Numerous experiments have been made with a view to testing the utility of oil in smoothing the approaches to exposed harbors in rough weather. The tests undertaken at Peterhead have met with unqualified success. The *modus operandi* has been to lay leaden pipes along the bottom of the harbor, taking care to keep the pipes stationary by means of concrete. The pipe is provided with numerous roses for disseminating the oil. When rough weather comes on, oil is forced along the pipes, and it escapes into the water through the apertures provided, and then, its specific gravity being less than that of water, it rises to the surface and quickly renders the sea less turbulent and the passage into the harbor quite safe. Another method employed to render safe ingress into harbors in bad weather is that of firing out to sea an oil-carrying projectile. This consists of a heavy tin tube weighted with lead at one end. The tube is filled with two or three quarts of oil, and the aperture stopped. When the projectile is fired from a gun or mortar, it reverses, and, the time-fuse exploding, the powder blows out the plug, and the liberated oil falls into the sea. A series of experiments conducted by a committee appointed by the United States Life-saving Service to inquire into the practical utility of oil-carrying projectiles, goes to confirm the statement made above, viz., that the power of oil to subdue the force of the waves in shoal water, or to prevent the waves breaking in surf, is very small indeed. There is one point, however, upon which all authorities who have tested the use of oil at sea are agreed. As an adjunct to the equipment of ships' boats it is simply invaluable. Many a shipwrecked crew have been enabled to keep their frail craft afloat until land was reached or a rescue effected, solely by its use. Nothing is more common among the records of shipwrecks than to read of the small boats either being swamped while at the vessel's side or capsizing through stress of weather. In January, 1884, the Cambria emigrant ship was run into by the Sultan in the North Sea, and, out of 522 on board, 416 were drowned. Of the four starboard boats no less than three capsized, and all their occupants perished. In the collision in the channel between the Forest and Avalanche, two out of three boats which left the Forest were swamped, and all on board lost their lives. These are but two instances out of many where lives *might* have been saved by the use of a little oil.

The subject of saving endangered life at sea is one that always enlists the deepest sympathies of all sorts and conditions of men. The perusal of the "Annual Wreck Chart," published by the Board of Trade, or of the lamentable records of personal sorrows and destitution consequent upon the disasters around our coasts, suggests the possibility that the loss of life might be considerably reduced by a practical knowledge of the best methods of applying oil during storms at sea. We think that much might be done by its use to facilitate the launching of boats from distressed vessels, and their safe subsequent navigation. Harbors of refuge on exposed coasts might be established at a very small cost.

In one department alone of our maritime industry, deep sea fishing, many lives might be saved. At present, the mortality among the carriers, *i. e.*, those engaged in carrying in small boats the fish from the smacks to the steam dispatch boats, is very great. Their boats might be equipped, at a very low cost, with oil tanks or oil bags to be used when trans-shipments are being effected in heavy weather. Already the governments of the United States and Germany have realized the vast importance of this subject, and have instituted an exhaustive series of experiments, with the view of rendering compulsory the carrying of oil for use as a life-saving equipment.

When that complex and overburdened instrument of government, the Board of Trade, was asked in Parliament to cause experiments to be made relative to the use of oil at sea, the reply was, that there were no funds available for the purpose; that the Board could not spend money or become investors in such schemes. The Consultative Committee appointed under the life-saving appliances act of last year have, however, suggested oil bags, among other equipments, to be carried by boats and rafts. At the International Maritime Conference at Washington, U. S., this subject has received the attention its importance merits. Further, the National Life Boat Institution and the National Sea Fisheries Protection Association have amalgamated their forces with a view to testing the efficacy of oil, but as yet the results of their investigations have not been published. While it is very gratifying to know that the man of science and the philanthropist are ready to explore the practical utility of this question, we cannot hope for any satisfying material results until the Board of Trade sees its way to take administrative action in the matter, and to deal in a fitting manner with a question that is so indissolubly connected with the interests of all classes of this great mercantile community.—*Nature.*

[FROM THE AMERICAN LAW REVIEW.]

SURFACE WATERS.*

VI. RIGHT TO APPROPRIATE.—Surface and percolating waters are deemed by the law to belong absolutely to the owner of the land upon which they are found. It is not water in a water course, or in an infinitesimal number of minute water courses, in the sense of being obedient to the law regulating the use of water flowing in natural channels, but is in the eye of the law the moisture, a part of the soil with which it intermingles, and the person who owns the soil may apply all that is found therein to his own purposes at his own free will.[27] The upper proprietor may drain it away or retain it upon his premises in reservoirs at pleasure,[28] and it is *damnum absque injuria* if he thereby cut off waters which would otherwise percolate to the lands of an adjoining proprietor, and form the source of a spring and rivulet,[29] or the supply from which the waters of a well or reservoir are drawn.[30] The same principle governs whether the property be divided by lateral or by vertical lines. Thus, if a person have granted the minerals in his lands, his grantee is entitled to work them so long as he does not affect the surface support, and if the result of the grantee's operations should be that the wells upon the grantor's lands are deprived of their supply, the latter has no remedy.[31] The owner has also an unqualified right to drain his lands for agricultural purposes in order to get rid of surface waters; and a neighboring proprietor will have no cause of complaint.[32]

But in New Hampshire the courts seem to have limited the right of the land owner to appropriate or divert waters. It has there been held that the land owner's right is limited to what is necessary in the use of his own land.[33]

On the question whether a proprietor can, without subjecting himself to any liability, appropriate or divert surface or percolating waters purely out of malice and for the purpose of injuring a neighbor who has hitherto enjoyed the flow and applied it to some useful and beneficial purpose, there is a conflict of authority. In the only two cases in which the point was directly involved and necessarily decided, the court held that even though the act were purely malicious, there could be no recovery.[34] On the other hand, it is to be noticed that many weighty *dicta* are to be found which countenance the view that for an act purely wanton and malicious the proprietor would be liable. The Supreme Judicial Court of Maine recently examined the question at great length, although it was not necessary to the decision of the case, and took the view that an action might be maintained. The action was brought to recover damages for wrongfully and maliciously cutting off the supply of a well or spring from which the plaintiff was entitled to draw water, and the court said: "We think this plaintiff had rights in that spring, which, while they were completely subject to the defendent's right to consult his own convenience and advantage in the digging of the well in his own land for the better supply of his own premises with water, should not be ignored if it were true that defendant did it 'for the mere, sole, and malicious purpose' of cutting off the sources of the spring and injuring the plaintiff, and not for the mere improvement of his own estate." In Massachusetts,[35] and Pennsylvania,[36] and also in an English case,[37] there are *dicta* in support of this view.

In keeping with the doctrine that surface and perco-

* Continued from SUPPLEMENT, No. 738, page 11785.

[27] Buffum v. Harris, 5 R. I. 243, 253; Acton v. Blundell, 12 Mee. & W. 324, 348; Curtis v. Ayrault, 47 N. Y. 73; Rawstron v. Taylor, 11 Exch. 382; Broadbent v. Rawbotham, 11 Exch. 602, 615; Frazier v. Brown, 12 Ohio St. 294; Roath v. Driscoll, 20 Conn. 533; *s. c.* 52 Am. Dec. 352; Goodale v. Tuttle, 29 N. Y. 459, 466; Chasemore v. Richards, 7 H. L. Cas. 349; Brown Illius, 27 Conn. 84; *s. c.* 25 Conn. 583; Taylor v. Fickas, 64 Ind. 167; New Albany & S. R.R. Co. v. Peterson, 14 Ind. 112; City of Greencastle v. Hazelett, 23 Ind. 186; Mosier v. Caldwell, 7 Nev. 363; Clark v. Conroe, 38 Vt. 46.

[28] Buffum v. Harris, 5 R. I. 243, 253; Acton v. Blundell, 12 Mee. & W. 324, 348; Curtis v. Ayrault, 47 N. Y. 73.

[29] Frazier v. Brown, 12 Ohio St. 294; Ellis v. Duncan, 21 Barb. 230; Taylor v. Welch, 6 Or. 198; Mosier v. Caldwell, 7 Nev. 363; Hanson v. McCue, 42 Cal. 303; *s. c.* 10 Am. Rep. 299.

[30] Brown v. Illius, 25 Conn. 594; *s. c.* 27 Conn. 84; Roath v. Driscoll, 20 Conn. 533; *s. c.* 52 Am. Dec. 352; New Albany & S. R.R. Co. v. Peterson, 14 Ind. 112; Hougan v. Milwaukee & St. P. R. Co., 35 Iowa, 558; *s. c.* 14 Am. Rep. 502; Grand Junction Canal Co. v. Shugar, L. R. 6 Ch. App. Cas. 483; Emporia v. Soden, 25 Kan. 608; Greenleaf v. Francis, 35 Mass. (18 Pick.) 117; Parker v. Boston & M. R.R. Co., 57 Mass. (3 Cush.) 107; Delhi v. Youmans, 45 N. Y. 362; *s. c.* 50 Barb. 316; Trout v. McDonald, 83 Pa. St. 144; Halderman v. Bruckhart, 45 Pa. St. 514; Chatfield v. Wilson, 28 Vt. 49; Ocean Grove Camp Meeting Assoc. v. Com'rs of Asbury Park, 40 N. J. Eq. 447.

[31] Trout v. McDonald, 83 Pa. St. 144; Coleman v. Chadwick, 80 Pa. St. 81.

[32] Rawstron v. Taylor, 11 Exch. 369; Greatrex v. Nayward, 8 Exch. 291; Chatfield v. Wilson, 28 Vt. 49; Buffum v. Harris, 5 R. I. 243; Waffle v. N. Y. Cent. R. Co., 58 N. Y. 11; *s. c.* 58 Barb. 413.

[33] Bassett v. Salisbury Manuf'g Co., 43 N. H. 569; Swett v. Cutts, 50 N. H. 49.

[34] Phelps v. Nowlen, 72 N. Y. 39; *s. c.* 28 Am. Rep. 93; Chatfield v. Wilson, 28 Vt. 53. It is to be noted that in a subsequent case the court of Vermont said with a reference to Chatfield v. Wilson; "The only criticism that we have heard on that decision was in respect to excluding the wanton and improper motive as an element in the ground of the defender's liability. In the present case there is no imputation of such motive." Thus evincing a desire to avoid any appearance of confirming the decision in the earlier case. See Harwood v. Benton, 32 Vt. 737.

[35] Greenleaf v. Francis, 35 Mass. (18 Pick.) 117.

[36] Wheatley v. Baugh, 25 Pa. St. 528; *s. c.* 64 Am. Dec. 721; Haldeman v. Bruckhart, 45 Pa. St. 514; *s. c.* 84, Am. Dec. 511.

[37] "If a man dig a well in his own field and thereby drains his neighbor's, he may do so, unless he does it maliciously," *per* Maule J., in Acton v. Bundell, 12 M. & W. 336. But see Lord Wensleydale's remark on the subject in Chasemore v. Richards, 7 H. L. 349, 388; and Martin, B., in Rawston v. Taylor, 11 Exch. 378.

lating waters form part of the soil upon or in which they are, it follows as a necessary corollary that if the proprietor of the lands appropriate percolating waters, and, by withdrawing them for his own use, remove the subjacent support of adjoining lands, the neighboring proprietor has no remedy, and it has been so held.[38]

The fact that the water has for years flowed over the surface of the upper proprietor's lands does not give the lower proprietor a right to its continued flow which will prevent the upper proprietor from appropriating it.[39]

VII. OBSTRUCTION OF FLOW.—1. COMMON LAW DOCTRINE.—Many cases have arisen out of obstructions placed by the lower proprietor to prevent the continued flow of surface waters over his lands. In dealing with these, the different courts have come into hopeless conflict, and have adopted either what is known as the common law rule or the civil law rule, so called. An examination of the decisions will reveal the fact that the courts which have adopted the common law rule have been influenced by and have followed the maxim *Cujus est solum, ejus est usque ad coelum, et ad inferos;* and have regarded any rule which requires the lower proprietor to allow the surface waters a free natural course over his lands as an infringement upon his proprietary rights. The leading case upon the side of the courts which have adopted the rule of the common law is the case of Gannon v. Hargadon.[40] In that case the court says: "*Cujus est solum, ejus est usque ad coelum*, is a general rule, applicable to the use and enjoyment of real property, and the right of a party to the free and unfettered control of his own land above, upon, and beneath the surface cannot be interfered with or restrained by any considerations of injury to others which may be occasioned by the flow of mere surface water in consequence of the lawful appropriation of land by its owner to a particular use or mode of enjoyment. Nor is it at all material, in the application of this principle of law, whether a party obstructs or changes the direction and flow of surface water by preventing it from coming within the limits of his lands, or by erecting barriers or changing the level of the soil, so as to turn it off in a new course after it has come within his boundaries. The obstruction of surface water or an alteration in the flow of it affords no cause of action in behalf of a person who may suffer loss or detriment therefrom against one who does no act inconsistent with the due exercise of dominion over his own soil." Stated briefly, under the common law rule, the lower proprietor has an absolute right to dam back surface water flowing from higher lands. An examination of the authorities shows that this rule has been adopted in Connecticut,[41] Indiana,[42] Kansas,[43] Maine,[44] Massachusetts,[45] Missouri,[46] New Hampshire,[47] New Jersey,[48] New York,[49] Rhode Island,[50] Vermont,[51] and Wisconsin.[52]

2. CIVIL LAW RULE.—In opposition to the common law rule, the rule of the civil law has been adopted in many States, and appears to be steadily growing in favor. This rule really rests on a twofold basis, though there has usually been only one reason assigned for it. It arises at once from the natural situation of the land, and the operation of the maxim *Sic utere tuo, ut alienum non lædas.* Being owner of the lower lands, the proprietor is by law bound to permit the unobstructed flow of surface water across them from the higher, and thus is under obligation to do no act which, by damming back the waters, would injure the upper proprietor. To express the rule in another form, the lands of the lower or servient proprietor are subject to a natural servitude under which he is obliged to receive from the lands of the upper or dominant tenement the surface waters which naturally flow therefrom. The right arises from the natural situation of the ground. Thus in one case[53] it was said: "The general principles of the law in the matter of rain water and drainage, and of the respective rights and duties of adjoining proprietors in relation thereto, . . . are in general the same as in the case of running water—they follow nature." In another case[54] the court said: "Almost the whole law of water courses is founded on the maxim of the civil law, *Aqua currit et debet currere*. Because water is descendible by nature, the owner of a dominant or superior heritage has an easement in the servient or inferior tenement for the discharge of all waters which by nature rise in or fall upon the superior." As a necessary result it follows that the owner of the lower tract has no lawful right to obstruct the natural flow of the water to the serious injury of the upper proprietor. The rule, as above stated, is now followed in Alabama,[55] California,[56] Georgia,[57] Illinois,[58] Iowa,[59] Louisiana,[60] Maryland,[61] Michigan,[62] Nevada,[63] North Carolina,[64] Ohio,[65] Pennsylvania,[66] and Tennessee.[67] In Texas, the courts hold that the statute requiring railroad companies to maintain sufficient sluices and culverts applies to surface waters as well as to streams, and railroad companies are thus prohibited from obstructing the flow.[68] In West Virginia, while there is no decision upon the point, there is a *dictum* which evinces a decided preference for the rule of the civil law.[69]

In Iowa[70] and in Pennsylvania[71]—States in which the civil law rule is recognized and followed—a distinction is drawn between city and village lots on the one hand and agricultural property on the other. In the former it is held that owners are entitled to improve their property for building, and that consequently no cause of action arises from the fact that the raising of the grade has obstructed the flow from an adjoining lot. The courts of Alabama seem to recognize the same distinction, although there is no decision directly upon the point.[72] Mr. Wood, in his book on the Law of Nuisances,[73] cites in support of this exception cases decided by the courts of New York[74] and New Jersey.[75] Those cases however form no authority for an exception which can only exist under the civil law rule, for the simple reason that both States follow the common law rule, under which neither the repulsion nor the diversion of surface waters gives rise to a cause of action.

3. MODIFIED DOCTRINE.—In one or two States a modified doctrine has sprung up, under which neither the common nor the civil law is followed. Under this doctrine, the courts endeavor to apply the law to the circumstances of each case, keeping in view the right of the obstructing proprietor on the one hand to have the reasonable use of his property, and on the other hand the restriction imposed upon him by the maxim *Sic utere tuo, ut alienum non lædas.* Applying this modified form, the supreme court of Arkansas has held that a railway company is liable to an action at the instance of a proprietor whose lands are injured by the obstruction of the surface water by an embankment which has been constructed without culverts or other openings to provide for its continued flow.[76] In South Carolina, in an opinion which discusses the matter at considerable length, although the question was not involved in the case, and therefore cannot be deemed to be settled, the supreme court expressed its preference for the modified rule adopted in Arkansas.[77]

(To be continued.)

[38] Smith v. Thackerah, 1 C. P. 564; Popplewell v. Hodkinson L. R. 4 Exch. 248.

[39] Parks v. City of Newburyport, 76 Mass. (10 Gray) 28; Swett v. Cutts, 50 N. H. 439.

[40] 92 Mass. (10 Allen) 106.

[41] Chadeayne v. Robinson, 55 Conn. 345.

[42] Cairo and Vincennes R. Co. v. Stephens, 73 Ind. 278; *s. c.* 38 Am. Rep. 139; Taylor v. Fickas, 64 Ind. 167.

[43] Atchison, T. & S. F. R. Co. v. Hammer, 22 Kan. 763; Gibbs v. Williams, 25 Kan. 214; *s. c.* 37 Am. Rep. 241; Kansas City & E. R. Co. v. Riley, 33 Kan. 374.

[44] Murphy v. Kelley, 68 Me. 521; Morrison v. Bucksport & B. R. Co., 67 Me. 352; Greeley v. Maine Cent. R. Co., 53 Me. 200; Bangor v. Lansil, 51 Me. 521.

[45] Rathke v. Gardner, 134 Mass. 14; Macomber v. Godfrey, 108 Mass. 219; Bates v. Smith, 100 Mass. 188; Franklin v. Fisk, 95 Mass. (13 Allen) 211; Gannon v. Hargadon, 92 Mass. (10 Allen) 106; Dickinson v. City of Worcester, 89 Mass. (7 Allen) 19.

[46] In Missouri there is a conflict of authority to some extent. In the earlier decisions the court adopted the common law rule. See Hosher v. Kansas City, St. J. & C. B. R. Co., 60 Mo. 329; McCormick v. Kansas City, St. J. & C. B. R. Co., 57 Mo. 433; Clark's Adm'r v. Hannibal & St. J. R. Co. 36 Mo. 224. In two decisions it followed the civil law rule. Shane v. Kansas City, etc., R. Co., 71 Mo. 237; *s. c.* 36 Am. Rep. 48; McCormick v. Kansas City, St. J. & C. B. R. Co., 70 Mo. 359; *s. c.* 35 Am. Rep. 435. But in its latest decisions it has reverted to the common law rule. Abbott v. Kansas City, St. J. & C. B. R. Co., 83 Mo. 271; *s. c.* 53 Am. Rep. 581; Stewart v. City of Clinton, 79 Mo. 603; Benson v. Chicago & A. R. Co., 78 Mo. 504.

[47] Swett v. Cutts, 50 N. H. 439; *s. c.* Am. Rep. 276.

[48] Bowlsby v. Speer, 31 N. J. L. 351. It must, however, be noted that in the subsequent case of Lord v. Carbon Iron Manuf'g Co., 42 N. J. Eq. 157, the vice chancellor has held that land on a lower level is under a natural servitude to that located above it, to receive the water flowing down to it naturally.

[49] Barkley v. Wilcox, 86 N. Y. 140; *s. c.* 40 Am. Rep. 519; Lynch v. Mayor, etc., 76 N. Y. 60; *s. c.* 32 Am. Rep. 271. In the earlier case of Vanderwiele v. Taylor, 65 N. Y. 341 *dicta* will be found which would appear to support the rule of the civil law, though in a modified form.

[50] Wakefield v. Newell, 12 R. I. 75.

[51] Harwood v. Benton, 32 Vt. 724. See also Beard v. Murphy, 37 Vt. 99.

[52] Lessard v. Stram, 62 Wis. 112; Hamlin v. Chicago & N. W. Ry. Co., 61 Wis. 515; O'Connor v. Fond du Lac, A. & P. Ry. Co., 52 Wis. 526; *s. c.* 38 Am. Rep. 753; Pettigrew v. Evansville, 26 Wis. 223; *s. c.* 8 Am. Rep. 50; Hoyt v. Hudson, 27 Wis. 656.

[53] Martin v. Riddle, 26 Pa. St. 415.

[54] Kauffman v. Griesemer, 26 Pa. St. 407.

[55] Farris v. Dudley, 78 Ala. 124; *s. c.* 56 Am. Rep. 24; Crabtree v. Baker, 75 Ala. 91; *s. c.* 51 Am. Rep. 424; Nininger v. Norwood, 72 Ala. 277; *s. c.* 47 Am. Rep. 412; Hughes v. Anderson, 68 Ala. 280; *s. c.* 44 Am. Rep. 147.

[56] Ogburn v. Connor, 46 Cal. 346; *s. c.* 13 Am. Rep. 213.

[57] Goldsmith v. Elsass, 53 Ga. 186.

[58] Totel v. Bonnefoy, 123 Ill. 653; Peck v. Herrington, 109 Ill. 611; Gormley v. Sanford, 52 Ill. 158; Gillham v. Madison Co. R.R. Co., 49 Ill. 484.

[59] Livingston v. McDonald, 21 Iowa, 160. It is to be noted that in Drake v. Chicago, R. I. & P. R. Co., 70 Iowa, 59, 61, the court cast some doubt upon the accuracy of the civil law rule. But see Sullens v. Chicago, R. I. & P. Ry. Co. (Iowa), 38 N. W. Rep. 345.

[60] Minor v. Wright, 16 La. Ann. 151; Hooper v. Wilkinson, 15 La. Ann. 497; Adams v. Harrison, 4 La. Ann. 165; Hayes v. Hays, 19 La. 351; Lattimore v. Davis, 14 La. 161; *s. c.* 33 Am. Dec. 581; Martin v. Jett, 12 La. 501; *s. c.* 32 Am. Dec. 120; Orleans Nav. Co. v. New Orleans, 1 Mart. 13.

[61] Philadelphia, W. & B. R. Co. v. Davis, 10 Cent. Rep. 551.

[62] Boyd v. Conklin, 54 Mich. 583.

[63] Boynton v. Longley, 19 Nev. 69; 3 Am. St. Rep. 781.

[64] Porter v. Durham, 74 N. C. 767; Overton v. Sawyer, 1 Jones L. 308.

[65] Tootle v. Clifton, 22 Ohio St. 247; Butler v. Peck, 16 Ohio St. 334; Crawford v. Rambo, 4 West. Rep. 445.

[66] Kauffman v. Griesemer, 26 Pa. St. 407; Martin v. Riddle, 26 Pa. St. 415; Hays v. Hinkleman, 68 Pa. St. 324.

[67] Louisville & N. R. Co. v. Hays, 11 Lea, 382; Carriger v. East Tennessee, V. & G. R. Co. 7 Lea, 388.

[68] Gulf, C. & S. F. Ry. Co. v. Helsley, 62 Tex. 503.

[69] In Gillison v. Charleston, 16 W. Va. 282, 303, the court, after an examination of the authorities, say: "A number of the authorities we have cited seem to recognize the principle that individuals and municipal corporations have the right to dispose of surface water in any manner they please to prevent its flow from adjoining lands upon their premises, although the result may be to flood the adjoining lands or not expel it, throw it upon the lands of their neighbors, and in either case are not liable to an action. These cases seem to lose sight entirely of the wholesome principle of ethics as well as law that a man may use his own property in any manner he pleases, provided he does not thereby interfere with the rights of his neighbors.

[70] Livingston v. McDonald, 21 Iowa, 160, 175, the Iowa Supreme Court adopted the rule of the civil law and applied it to circumstances arising out of the drainage of agricultural lands. Dillon J., who delivered the opinion out of the court, said: "In so holding we do not lay down any rule applicable to town or city property." In Philips v. Lansing, 69 Iowa, 199, it was held that the owner of a city lot is entitled to so improve as to cast surface water upon the adjoining street or alley at the established grade; and that he was not liable for damages caused by the flowing of such water upon a neighboring lot which is below grade.

[71] Bentz v. Armstrong, 8 W. & Serge. (Pa.) 40.

[72] See Farris v. Dudley, 78 Ala. 124; *s. c.* 56 Am. Rep. 24; Crabtree v. Baker, 75 Ala. 91; Nininger v. Norwood, 72 Ala. 277; *s. c.* 47 Am. Rep. 412.

[73] 2d ed., sec. 392.

[74] Pixley v. Clark, 35 N. Y. 532; Goodale v. Tuttle, 29 N. Y. 467.

[75] Bowlsby v. Speer, 31 N. J. L. 352.

[76] Little Rock & F. S. Ry. Co. v. Chapman, 39 Ark. 463; *s. c.* 43 Am. Rep. 280.

[77] Waldrop v. Greenwood, L. & S. R. Co., 28 S. C. 157; Am. & Eng. R. R. Cas. 204.

THE THEORY OF WATER GAS.*

ALEX. C. HUMPHREYS.

IN considering the amount of energy that will be theoretically required for the decomposition of a given quantity of water, we could go directly to the resulting hydrogen and obtain its calorific value; the value so obtained would be the energy required, for the water in itself possesses no energy. While it is composed of hydrogen and oxygen, and hence has as one of its constituents a most inflammable gas, there is required for the decomposition of the water the same amount of energy as is given out during its formation.

Were this otherwise, and we could obtain an increment of energy from this decomposition, we might in the first instance supply an amount of fuel required for the decomposition of a given amount of water, pay back our fuel advanced, and use the increment as fuel for obtaining a further supply of energy from the water without cost. In other words, the conservation of the energy of the universe would be destroyed. But we have simply a cycle of changes; for we first decompose water and then combine it in combustion, and use the heat given out by that combustion instead of the heat expended upon the decomposition of the water.

* From "Water Gas in the United States."

If no energy is supplied from outside sources, there can be no energy obtained from water; we use the water as a vehicle to carry the energy supplied from other sources. In the case of a fuel we readily recognize the difference. Here we have energy that nature ages ago stored away, and if we bring about the combustion of this fuel, we are enabled to collect this stored energy and make use of it.

During such combustion, bodies widely different from the original fuel are formed. If, as in the case of water decomposed, the fuel was restored to its original form, we should be obliged to supply the same amount of energy previously collected, and we should have gained nothing. But, in the case of the fuel, we do not have any such complete cycle.

To trace, in a measure, the changes incident to the formation of water gas, I will, however, compute in detail the energy required, and make the proper comparisons.

The matter seems so simple that it may be deemed absurd to further press this point, but such wild claims and statements have been made during the past year, on both sides of the Atlantic, for water gas that I am persuaded to be explicit. It will be convenient to always express energy in British thermal units.

I will assume that we are working under a temperature of 62° F. and a pressure of 1 atmosphere. I will assume that the carbon and the steam required for our reaction are to be treated at 1,832° F. (say 1,000° C.), as Sainte Claire Deville* tells us that at that temperature vapor of water is in a condition of dissociation and ready to decompose under the influence of the least cause, mechanical or chemical. For the total heat of gasification of water we have the formula† $h = a + c'(T - To)$ where $a = 1{,}092$ and c' = specific heat of the substance under constant pressure = 0·475. And we have $h = 1{,}092 + 0·475\ (1{,}832 - 62) = 1932·75$ B. T. U. per pound. For the specific heat of the carbon we can take that of anthracite and coke = 0·20204.‡

To raise the carbon from 62° to 1832°, we shall require an amount of energy given by the expression $(1832 - 62) \times 0·20204 = 358$ B. T. U. per pound.

Upon the decomposition of the water, the oxygen will go to the carbon to form CO_2, and subsequently being reduced to the state of CO, the result is the formation of carbonic oxide accompanied by a development of heat. I assume as a fair number for the total heat of combustion of carbon burning to CO_2, 14,500 B. T. U., and I assume, for the same number, in the case of CO, 4325 B. T. U. per pound. One pound of carbon burning to CO_2 gives 14,500 B. T. U.; 1 pound of carbon as CO (= $2\frac{1}{3}$ pounds of CO) will give $2\frac{1}{3} \times 4{,}325 = 10{,}100$ B. T. U.

Hence C burning to CO gives $14{,}500 - 10{,}100 = 4{,}400$ B. T. U. per pound.

This amount of energy per pound of carbon will assist in the decomposition of the water, but from it we should deduct the amount of energy expended in raising the carbon from 62° to 1,832° as shown = 358 B. T. U. per pound; leaving for the net credit per pound of carbon $4{,}400 - 358 = 4{,}042$ B. T. U.

We will now find the energy required for the treatment of 1 pound of water containing $\frac{1}{9}$ pound of hydrogen and $\frac{8}{9}$ pound of oxygen.

In the production of CO, 1 pound of carbon would require $1\frac{1}{3}$ pounds of oxygen; hence for $\frac{8}{9}$ pound oxygen we require $\frac{2}{3}$ pound of carbon; these two giving $1\frac{5}{9}$ pounds of carbonic oxide.

To raise the 1 pound of water to superheated steam at 1,832° F. requires, as shown..............		1932·75	
The constituent $\frac{8}{9}$ pound of oxygen will combine with $\frac{2}{3}$ pound carbon, which carbon must be supplied from the incandescent coal, and will have an energy = $14{,}500 \times \frac{2}{3}$ = ...		9666	
			11598·75 B. T. U.
To decompose the 1 pound of water requires an amount of energy = $\frac{1}{9} \times 62{,}032$ = ...		6892	
But we have already supplied to the steam, as shown above..............	1932·75		
And the combustion of $\frac{2}{3}$ pound of carbon with oxygen to form CO will supply $\frac{2}{3} \times 4{,}042$ = ...	2694·7	4626·5	
Leaving an amount of energy yet to be supplied................			2264·5
And making the total energy expended per pound of water......			13,863 B. T. U.

From this decomposition we have a gas composed of equal volumes of hydrogen and carbonic oxide, or by weight $\frac{1}{9}$ pound hydrogen and $1\frac{5}{9}$ pounds CO. The energy possessed by this gas will be—

$$\begin{aligned} 62{,}632 \times \tfrac{1}{9} &= 6{,}892 \\ 4{,}325 \times 1\tfrac{5}{9} &= 6{,}728 \\ \hline &\ 13{,}620 \text{ B. T. U.} \end{aligned}$$

These two numbers, 13,863 and 13,620, should balance each other. Their failure to do so simply shows that the correct amount of energy has not been obtained in calculating the raising of the cold carbon to the temperature for combustion. Enough has been done to point out the connection existing between the several reactions.

The amount of energy required for obtaining from 1 pound of water and the accompanying carbon $\frac{2}{3}$ pound hydrogen and $1\frac{5}{9}$ pounds of CO, I shall take to be 13,620 + B. T. U. From this we see that at a moderate estimate of calorific value, good anthracite will theoretically more than take care of the water, pound for pound.

We will now consider the question of the energy ex-

* *Phil. Mag.*, xx., p. 453.

† Rankine, "Steam Eng.," § 216.

‡ Clark's "Constants of Nature."

pended in the production of 1,000′ of non-luminous water gas. We have water composed of hydrogen 2 volumes and oxygen 1 volume. But the oxygen goes to 1 volume of carbon to form CO, which gas contains by volume only ½ of oxygen; that is, it does not contract in combining. Hence, we have for the CO, O, 1 volume and C, 1 volume = 2 volumes. And our theoretical water gas is composed of equal volumes of hydrogen and carbonic oxide.

	Pounds.
500′ of hydrogen will weigh 0·00527 × 500 = ...	2·635
And the oxygen combined with this amount of hydrogen to form water will weigh 2·635 × 8 = ...	21·08
Giving for the weight of water required.	23·715
The constituent carbon will weigh 21·08 × ¾ = ...	15·81
The CO will weigh 21·08 + 15·81 = ...	36·89
And the 500′ of hydrogen plus the 500 of CO will weigh 2·635 + 36·89 or 23·715 + 15·81 = ...	39·525

The energy required for the production of this 1,000′ of gas will be 13,620 × the number of pounds of water decomposed (= 23·715 pounds) = 322,998 B. T. U., and this, of course, must equal the theoretical calorific value of the gas:

$$\begin{aligned} 2{\cdot}635 \times 62{,}032 &= 16{,}3454 \\ 36{\cdot}89 \times 4{,}325 &= 15{,}9549 \\ \hline &32{,}3003 \text{ B. T. U.} \end{aligned}$$

which it does if allowance is made for decimals omitted in the number 13,620.

I know that some who find me taking so much space to cover what is to them apparent may feel that an apology is due from me. My apology is that an explicit statement seems to be required to meet the claims sometimes made for the "benefit" of investors.

The province of water gas is an important enough one without making for it claims that cannot be upheld by the facts; for by this process, and by this process only, we are enabled to convert solid fuel, such as anthracite and coke, into gaseous fuel. While we can distill gas from gas coal, we still have the solid carbon left, which cannot be utilized except as solid fuel. By the intervention of water gas methods, and only in this way, can this solid fuel be transformed into gas for general distribution.

And even with the bituminous or gas coals, where the coal gas methods would have to stop, leaving about two-thirds of the original fuel still not reduced to gaseous form, the water gas methods, as I shall afterward point out, can take up the good work and not let go until only the ash is left to be removed from the apparatus. Surely, in this age of fuel gas, we need claim no more.

ON THE MOST ECONOMICAL ENGINE FOR SMALL POWER.

By Prof. J. E. Denton.

A certain machine shop possesses two steam engines, one a plain slide valve throttling 5½ in. bore by 7 in. stroke, the other an automatic cut-off, 7 in. bore by 14 in. stroke, both non-condensing. The shop required seven horse power to run it, exclusive of the power to overcome the friction of the engine. The question arose whether it was cheaper to run the shop at seventy pounds boiler pressure with the plain slide valve engine cutting off at three-quarters or with the 7 in. by 14 in. engine cutting off at one-fifth under the automatic action of its governor, or whether fuel would be saved by operating the engines on the compound principle, using the small engine as the high pressure cylinder, and exhausting from it into the larger engine through a receiver, the system still being non-condensing. Both engines were carefully overhauled and made perfectly tight at their valve seats and pistons. Each engine was then tested to determine the power absorbed to run itself, with the result that the small engine consumed $\frac{6}{10}$ horse power and the large engine 2½ horse power. The small engine was then made to perform 7¾ indicated horse power at 70 pounds boiler pressure and 146 revolutions per minute, the exhaust escaping into the atmosphere at a back pressure of 17 pounds. The steam consumption per hour per horse power was 45 pounds. The large automatic engine was then made to perform about the same indicated horse power at the same steam pressure and revolutions, the cut-off being about one-fifth. The steam consumption per hour per horse power was 35 pounds. The same was then performed by operating the engines on the compound system at the same boiler pressure and same cut-off in the small engine and with 26 pounds receiver pressure, and about one-half cut-off in the larger engine, the exhaust passing into the atmosphere from the larger cylinder. The ratio of the two cylinders made the ratio of expansion 4⅓, including clearance, or practically the same as the real ratio of expansion when the large engine was used alone, the clearance of the latter being five per cent. The steam consumption per hour per horse power was 33 pounds. It follows from these results that to obtain the seven net horse power required to operate the shop the indicated horse power for the three methods would be as follows:

System.	Friction.	Net Work.	Total or Indicated H. P.
Small engine........	0·6	7	7·6
Large engine........	2·5	7	9·5
Compound engine......	3·1	7	10·1

The expense measured in steam consumed per hour will, therefore, be as follows:

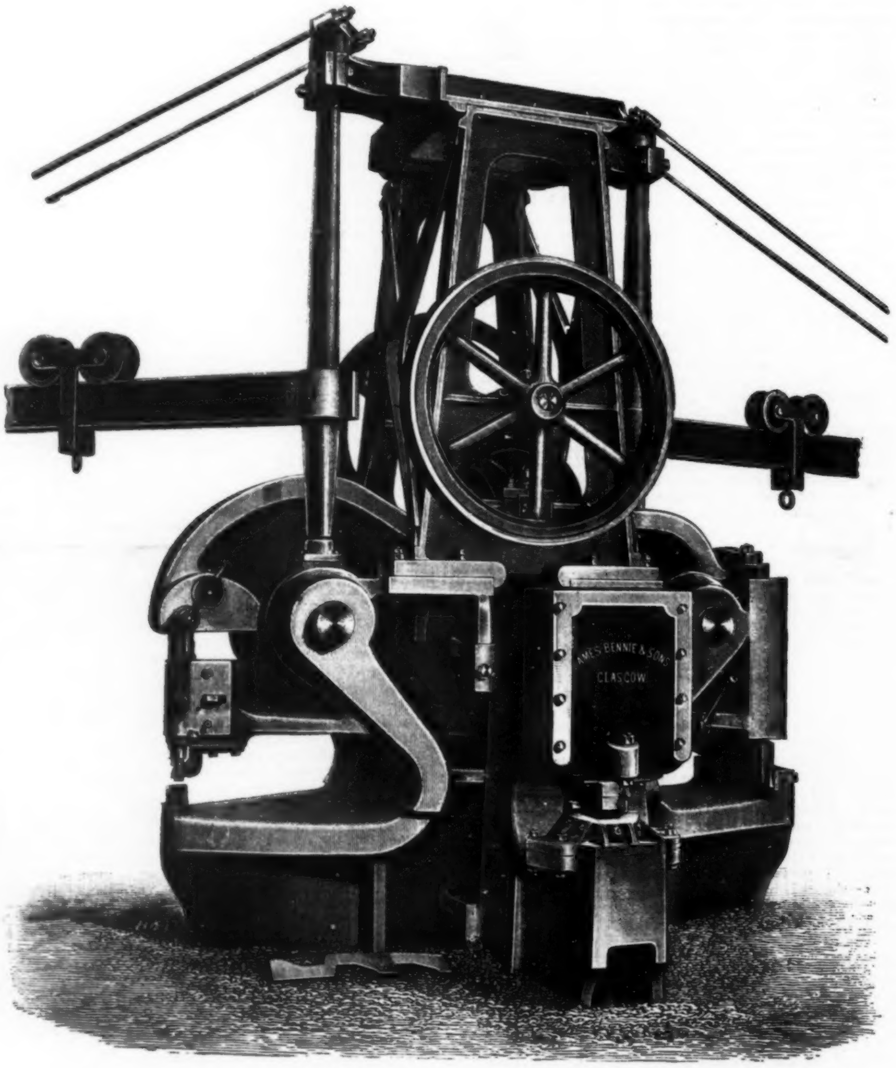
Small engine	7·6 by 45 = 342 lb.
Large engine	9·5 by 35 = 333 lb.
Compound engine..........	10·1 by 33 = 333 lb.

It is evident that so far as the coal consumed is concerned, the three methods are practically equal. The best method will, therefore, be the one which gives the least wear and tear or the least trouble to apply, the first cost being too small in both cases to make interest a sensible factor. This makes the most economical method that which derives the required power with the large engine alone, as the load upon it is only about half its working capacity, and, consequently, the wear and tear is very light, and, as a matter of fact, the engine has done the work for years with far less attendance and repairs than would be required if the small engine was made to perform the required work. It is worthy of note that the greater proportional power required to overcome the friction of the automatic engine is due to the fact that its main shaft and fly wheel, which cause the greater part of the friction, weigh much more in proportion to the total mean pressure on its piston than is the case with the small engine.—*Stevens Indicator.*

LARGE LEVER PUNCHING MACHINE.

The increase in the size of plates commonly used for shipbuilding has brought about the development of plant of corresponding size and power. In many shipbuilding and engineering establishments the pressure of work this winter has compelled many firms to spend considerable amounts of capital in heavy plant. Boiler making tools of large size for manipulating the enormous plates that now enter into the construction of a modern marine boiler for engines of 4,000 horse power and upward have especially undergone recent development.

The mere size of such machinery has brought about, as a necessary consequence, development in design, the main ideas being, of course, to secure great strength with simplicity of working parts. The large lever punching machine which we illustrate above has just been made by Messrs. James Bennie & Sons, Clyde Engine Works, Polmadie, Glasgow. The machine is capable of punching 1⅛ in. holes through a 1⅛ in. plate. The gap on the punching end is 42 in. deep, so that a hole can be punched in the center of a plate 7 ft. broad. A very broad shearing slide is also fitted, the blades of which are 3 ft. long. A separate arrangement is fitted at the side for punching out at one stroke large square holes in stringer plates and also limber holes or small man holes. When placed in position the machine is sunk sufficiently to permit the punching to take place at a convenient level. Cranes are attached to the machine, for manipulating plates up to 2 tons in weight. A special high frame on the machine supports the cranes, and thus makes the whole plant quite self-contained.—*Industries.*



LARGE LEVER PUNCHING MACHINE.

A NEW METHOD OF PREPARING FLUORINE.

A new method of preparing fluorine has been discovered by M. Moissan. This discovery is the outcome of the success which has attended M. Moissan's efforts to prepare anhydrous fluoride of platinum. During the process of his memorable work upon the isolation of fluorine by the electrolysis of hydrofluoric acid containing hydrogen potassium fluoride, one of the most remarkable phenomena noticed was the rapidity with which the platinum rod forming the positive electrode was corroded by the action of the liberated gaseous fluorine. It was surmised that a fluoride of platinum was the product of this action, but hitherto all efforts to isolate such a body have proved unsuccessful. In fact, for a reason which will be discussed subsequently, it is impossible to prepare platinum fluoride in the wet way. M. Moissan has, however, been enabled to prepare anhydrous platinum flouride by the action of pure, dry fluorine itself upon the metal. It was found at the outset that, when fluorine is free from admixed vapor of hydrofluoric acid, it exerts no action whatever upon platinum, even when the latter is in a finely divided state, and heated to 100 deg. C. But when the temperature of the metal is raised to between 500 deg. and 600 deg. C., combination readily occurs with formation of tetrafluoride of platinum and a small quantity of protofluoride. The moment the gas is mixed with a little vapor of hydrofluoric acid, the action is immensely accelerated, and then occurs readily at ordinary temperatures.

The same rapid action occurs when platinum is placed in hydrofluoric acid saturated with free fluorine, which accounts for the disappearance of the positive terminal during the electrolysis. In order to prepare the fluoride of platinum, a bundle of wires of the metal is introduced into a thick platinum or fluorspar tube, through which a current of fluorine gas from the electrolysis apparatus is passed. On heating the tube to low redness, the wires become rapidly converted to fluoride, when they are quickly transferred to a dry stoppered bottle. If the operation is performed in a platinum tube, a large quantity of fused fluoride remains in the tube. The tetrafluoride of platinum, PtF_4, formed upon the wires, consists either of fused masses of a deep red color or of small buff-colored crystals resembling anhydrous platinum chloride. It is exceedingly hygroscopic. With water it behaves in a most curious manner. With a small quantity of water it produces a fawn-colored solution, which almost immediately becomes warm, and decomposes, with precipitation of hydrated platinic oxide and free hydrofluoric acid. If the quantity of water is greater and the temperature low, the fawn-colored solution may be preserved for a few minutes, at the expiration

of which, or immediately on boiling the solution, the fluoride decomposes in the manner above indicated. This peculiar behavior with water explains the impossibility of preparing the fluoride in the wet way. When the anhydrous fluoride is heated to bright redness in a platinum tube closed at one end, fluorine at once begins to be evolved as gas, and if a crystal of silicon be held at the mouth of the tube, it takes fire and burns brilliantly in the gas. The residual platinum is found, on examining the contents of the tube, to consist of distinct crystals of the metal. Hence by far the most convenient method of preparing fluorine for lecture purposes is to form a considerable quantity of the fluoride first by passing the product of the electrolysis over bundles of platinum wire heated to low redness, and afterward to heat the fluoride thus obtained to full redness in a platinum tube closed at one end.

It only remains now to discover another method of preparing fluoride of platinum in the dry way, to be able to dispense with the expensive electrolysis apparatus altogether. M. Moissan has also prepared a fluoride of gold in the same manner. It is likewise very hygroscopic, decomposable by water, and yields gaseous fluorine on heating to redness.—*Nature.*

NEW COUNTERS FOR HACKS.

THE municipal authorities of Paris have just held a competitive exhibition of counters to be applied to hacks. We need not tell any one how defective the present tariff is, nor to how many complaints it has given rise on the part of the public, coachmen, and livery stable keepers. Everybody is agreed in demanding a reform. The idea of a tariff to a distance and that of a counter indicating the distance traveled, appears to contain the most perfect solution of the question. The problem, however, is not as simple as it appears at first sight.

If it were never a question of anything but simple trips, and the counter merely had to make known the length of each of them, the tasks of inventors would be relatively easy; but it becomes complicated when the apparatus is required to keep account, not only of the distances traveled, but of the stoppages and retardations ordered by the customer. In this case, it is necessary that the counter shall be both kilometric and horary, and that it shall permit of seeing at a glance the sum due the coachman for the entire service rendered. Still, this furnishes only a means of settling the account between the coachman and customer; the counter, to be complete, should also furnish the owner of the hack a means of verifying the receipts, that is to say, it should register the day's work. Finally, let us add that it should not cost much, should occupy but little space, and should not be capable of getting out of order either through accident or dishonest tampering with it.

At the competition, no less than 129 different systems were shown, most of which, visibly inadequate or defective, were at once rejected. Three only were selected for a two months' trial, those of Quinche, Chauffriat, and Bellussich, which we illustrate herewith. All three are kilometric.

They indicate the distance traveled in the case of a simple drive to a certain destination, but if the customer gets out of the hack, or makes the coachman drive slowly (at a funeral, for example), the horary system comes into play. The counter, instead of marking the distance really traveled, runs at the conventional speed of eight kilometers per hour, even during stoppages.

Let us suppose, for example, that the hack is hired by a customer who wants to go four kilometers from the starting point to make a quarter of an hour's visit, and afterward to go five kilometers farther. The counter will have to register:

First trip (kilometric).................	4 kilom.
Stoppage (horary)........	2 "
Second trip (kilometric).............	5 "
Total	11 "

If the scale of prices has been established at the rate of 25 centimes per kilometer, the dial will show both the number of kilometers (11) and the sum to be paid ($2\frac{3}{4}$ francs).

In all three systems, it is the motion of one of the hind wheels that is transmitted to the needle during the kilometric running, while it is clockwork that moves it at the conventional velocity of eight kilometers per hour under the horary running. In order to pass from one system to the other, the needle must therefore be actuated by either one or the other of the two motors, and, besides, it is necessary that it shall remain at rest if the hack is not let. In the Quinche and Bellussich systems, the maneuver is confided to the coachman, and is effected through a lever that causes either the words "To Let" or "Engaged" to appear. In the Chauffriat apparatus, the change is made automatically.

As for the transmission of motion from the hind wheel to the needle, that in the Quinche system is effected by an eccentric, and in the two others pneumatically.

By totalizing, the three apparatus register the day's receipts, either upon small accessory dials or by means of curves traced upon a disk.

Let us add that the Bellussich system presents an additional check, furnished by the customer himself. The seat and cushion are separated by a spring that holds them a slight distance apart.

When the passenger sits down, his weight closes the circuit of a small battery, that sets the counter in motion, even though the coachman has omitted to maneuver his lever.—*L'Illustration.*

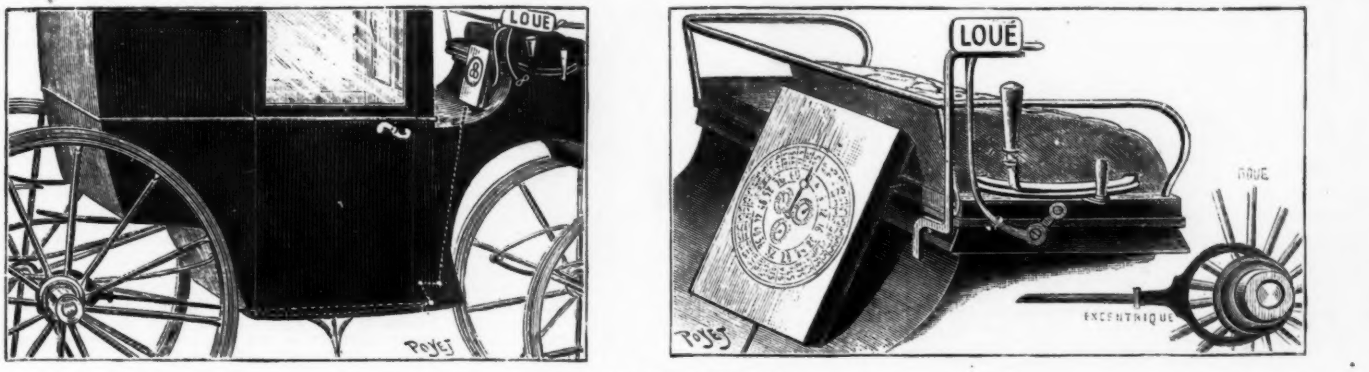


FIG. 1.—QUINCHE SYSTEM.

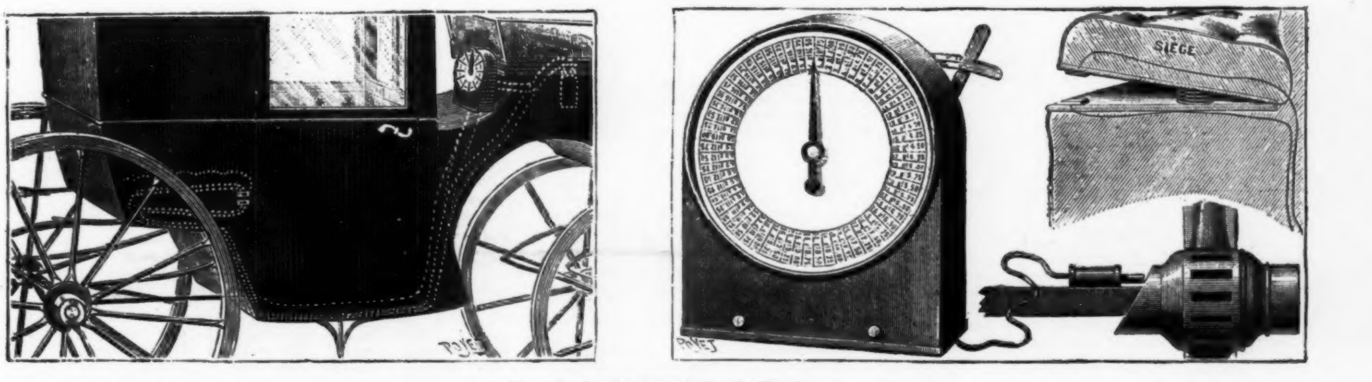


FIG. 2.—BELLUSSICH SYSTEM.

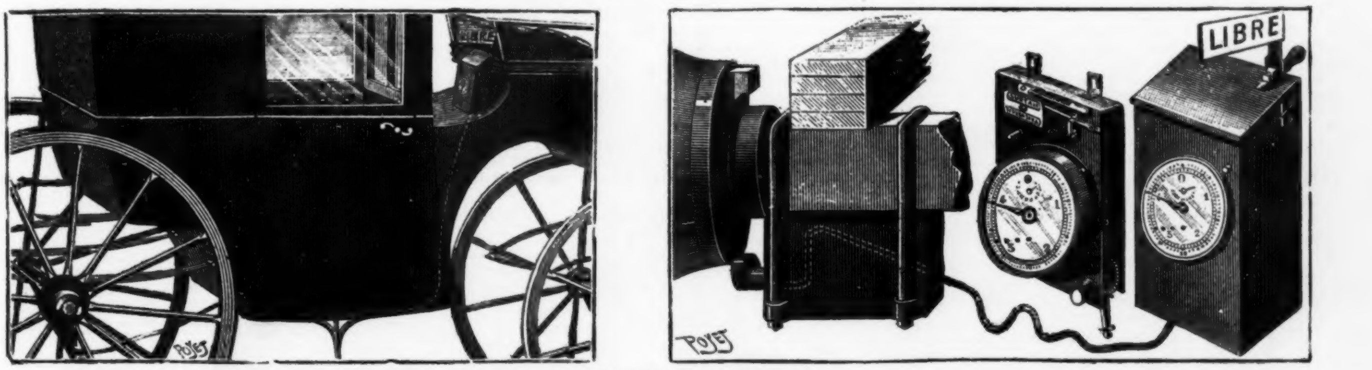


FIG. 3.—CHAUFFRIAT SYSTEM.

COUNTERS FOR HACKS.

PILE PROTECTION.

MR. J. A. PRITCHARD not long since read before the Ohio Society of Surveyors and Civil Engineers a very interesting paper on the subject of "Pile Protection." An extract of this paper is appended:

It has been a study with land owners along the streams (I would add here by way of parenthesis that I refer to those who believe in taking care of land, and not those who allow things to go to rack) to devise some effective and cheap method of protecting banks and levees. Some have tried to do this by building cribs of round timber and filling with brush and bowlders. These caused the wash to be more instead of less, and were considered failures. Others have built brush dams, excavated new channels and changed the course of the stream. While one attempt at this was successful, others failed, and the expense of making a new channel was considerable. In the fall of 1887, there was commenced a system of pile protection, of which there was put in at that time 742 ft. in all, which consisted of three wings, and 546 ft., which was in one continuous curve of about 475 feet radius, the piles of which were driven close up to the bank and sheeted on the water side with 2 inch oak sheeting. But it is the wings that I wish to speak of, as to place a continuous sheet along the water front of a large farm that is liable to wash would be rather expensive. The wings are constructed in the following manner: No. 1 is located where the creek makes a curve of 800 feet

radius, and consists of thirteen piles seven feet from center to center, seven of which were driven close up to the bank. The remaining six were placed across the stream at an angle of 45°. Brush was then laid across the line of piling well out into the stream. The bottom plank of the sheeting was then forced down on the brush and made fast by 6 inch wire spikes. The sheeting was placed behind the piles on the bank part, and is held in place by a back filling of brush and gravel. On the part which extends into the stream, the sheeting is placed on the front or upper side, and is secured to the piles by 6 inch wire spikes. The top piece of sheeting is made double, and in such a manner as to break joints, and is bolted with ½ inch bolts, two to a pile. The extreme 35 ft. which extends into the stream is double sheeted, and in such a manner as to break joints between the piles, and is bolted at the joints to a 4 inch by 6 inch stay, placed behind the sheeting, with ½ inch bolts. The piles were driven by horse power with an 800 pound hammer. The leads were placed on a common farm wagon, and were about 16 ft. full length. The length of this wing is 84 ft. An estimate of the cost would be:

Thirteen piles, fourteen feet long, at $1.50	$19.50
Driving same, at $1.50	19.50
Boarding three men and team	5.00
Sheeting, 1,320 feet, at B. M. $68 per 1,000	24.90
Placing sheeting and back filling	10.00
Bolts and spikes	3.00
Total	$81.90

I would here say that the cost of the whole 742 ft. was between seven and eight hundred dollars, or about one dollar per foot. The effects of this wing has been to protect the bank for about 400 feet, at which point the wash originally began, on the opposite side, but since the wing has been placed, has begun further up the stream. It also had the effect of deepening the channel, which before was about 2½ ft. and now is 4½ ft. deep. Wings Nos. 2 and 3 are built in the same manner, but with a more favorable location and 28 ft. less in bank part. No. 3 failed, the stream end having washed out when the ice broke up in the spring of 1888. The depth of water where it stood is now about 11 ft. Wing No. 3 is 190 feet below No. 2, and the current does not strike the bank between them, although they are on a curve with a radius of 475 ft. One hundred and sixty feet from wing No. 3 the continuous sheeting begins. My opinion is that the better practice would be to cross the current at an angle not to exceed 20°, and continue the wings 20 to 30 ft. further, according to circumstances, and the piles should be longer than those used in this case, and be driven lower, so that when the ice breaks up, with a moderately high water it could flow over the top of the wing. And there should be two piles driven from 8 to 10 ft. back of the wings, and two heavy round timber braces placed at the end pile and the third from the end to insure stability, as the weight sustained during an ice gorge is tremendous. I am not aware that any engineer was called on to plan or locate the work that has been done, but I think that by being properly located, a wing, not to exceed a cost of eighty dollars, can be made to protect a bank from 200 to 500 ft., according to the curvature of stream where located.

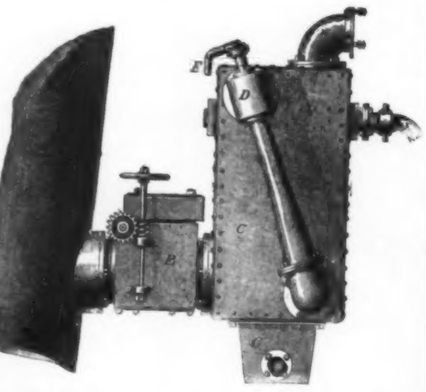
PAPER MACHINES AT THE PARIS EXHIBITION.

Fig. 1 represents the paper machine of Messrs. De Naeyer & Co., of Belgium; Fig. 2 the machine of Messrs. Dautrebande, & Thiry, of Huy, Belgium; and Fig. 3 that of Messrs. Escher, Wyss & Co., of Zurich. We regret that an outline drawing of the fourth paper machine, which was exhibited by Messrs. Darblay, of Essonne, France, is wanting. For the drawings here published we are indebted to a French paper-making newspaper called the *Moniteur de la Papeterie*, as also to M. Debie's publication.

These paper machines may be taken as fairly representative of Continental types of construction, excluding Germany, of course, during the last few years. As compared with machines, say, ten or fifteen years ago, we notice first that a great deal more attention is paid to detail and good workmanship than formerly; chilled iron, instead of cast iron rolls, have been more generally introduced, and the framing is altogether stronger and stiffer throughout these modern paper machines. The latter improvement has been made in order to keep pace with the much higher rates of speed required, and to supply the demand for cheaper and thinner papers containing a large quantity of wood fiber.

The next point in these machines to which we would direct attention is the greater accessibility to the different parts for the workmen. The facilities for leading the paper through the various rolls, cylinders, presses, etc., have been particularly studied, and the chances of accident to the men much diminished in consequence. The somewhat difficult operation of passing the paper over and through the innumerable rolls and cylinders at, say, 200 feet a minute, has been greatly simplified. The driving tackle is also better arranged for adjusting all the various speeds than it was in former years, and conical pulleys are now used on all the side shafting for regulating quickly and easily the different parts of the machine.

The press rolls in these modern machines are generally larger in diameter than formerly. Lastly, we notice that in each of them the present practice is to have felts to all or nearly all the drying cylinders, and each felt is provided with its separate drier, so as to dry it as much as possible.—*Engineering.*



APPARATUS FOR EXTINGUISHING FIRE IN A SHIP'S HOLD.

APPARATUS FOR EXTINGUISHING FIRE IN A SHIP'S HOLD.

In the accompanying illustration is shown a novel and most effective apparatus for extinguishing fires in ships' holds, and for rapidly ventilating the holds in emergencies, by Coates & Carver, Manchester. It has been found to admirably answer the purpose for which it is intended. The gases produced by the combustion of coal, and which pass up the funnel, are carbonic acid gas, nitrogen, and traces of sulphurous gases. Neither carbonic acid gas nor nitrogen will support combustion, and where these gases are present in sufficient quantity oxidation is impossible, and consequently a fire will not burn. In the event of carbonic oxide gas being formed (as sometimes occurs) a similar result will take place. This is the scientific basis of the invention. Fire is extinguished in a ship's hold by the apparatus filling it rapidly with fumes extracted from the boiler funnel, and cooled and purified on their way to the hold, vents being left open for the expulsion of fresh air contained in the hold. The fumes are injected with such rapidity as to produce an outflow through all vents and crevices in the hold, and thus prevent the ingress of fresh air which would otherwise occur. A boiler burning two cwts. of coal per hour evolves sufficient fumes for this purpose, and it is claimed for the apparatus that it is applicable to any vessel, whether a steamer or a sailing ship, having a boiler in which coal can be consumed at this rate. The fumes are deadly to fire, whether it result from the combustion of ordinary cargo or of such dangerous substances as turpentine, petroleum, benzoline, gasolene, or even phosphorus; consequently, when a hold is filled with the fumes, it is effectually protected throughout against fire. After a fire has been extinguished, or at other times when the atmosphere in a hold is in a vitiated condition, the apparatus can be set to force in a large stream of fresh air, and thus rapidly purify the atmosphere.

Referring to the illustration, the following is a description of the apparatus and the manner in which it is set to work: A is a part of a boiler funnel; B, a valve box, having a valve which can be set so as to admit to the apparatus either fumes from the funnel or fresh air, as may be required; C, a galvanized iron chamber, divided into two compartments by a vertical partition; D, a steam jet blower, which sucks from one compartment of the chamber, C, and delivers into the other; E, the end of a pipe supplying steam to the blower from the boiler; F, the end of a pipe supplying water for producing a shower in each compartment of the chamber, C; G, a trap through which the waste water flows out of the two compartments of the chamber (a pipe is connected to this trap for leading the waste water away); and H, an outlet for the fumes from the delivery compartment of the chamber, C (delivery pipes are connected to this outlet for conveying the fumes to any required hold). To set the apparatus to work, water and steam are turned on. The steam, in passing through the blower, draws into the suction compartment of the chamber, C, through the valve box, B, either fumes from the funnel or fresh air (according to the position of the valve), and then forces the current into the delivery compartment of the chamber, and through the outlet, H, into the delivery pipes, under a pressure which does not exceed two pounds per square inch. The current flows through both compartments of the chamber in an upward direction, and in each becomes intermingled with a descending shower of cold water. The shower in the suction compartment cools the funnel fumes before they reach the blower, and that in the delivery compartment cools and dries the current, whether of fumes or of air, after it has been warmed and moistened by admixture with the steam used in the blower.

In connection with a trial of the apparatus made before several representatives of the Liverpool Salvage Association, Captain Chisholm, the chief surveyor of the association, in a letter to Mr. Carver, after describing the tests to which the apparatus was put, said: "I am of opinion that your plan of injecting gases from the funnel is more efficacious than steam for extinguishing fires on board steam vessels."—*The Steamship.*

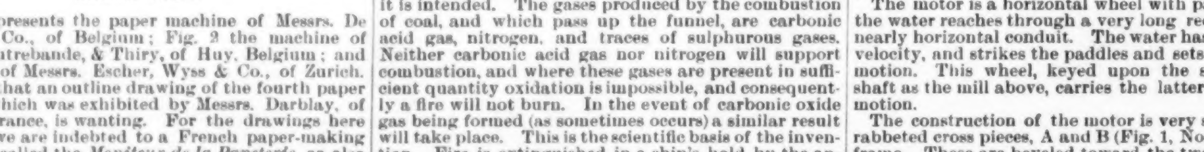
THE FLOUR MILL IN ALGERIA.

The flour mill has remained in Algeria what it must have been at the time of the conquest. It consists of but two parts, the motor and the stones. Bolting is either entirely dispensed with or is performed by hand in an elementary manner with a rude horsehair sieve, which separates the bran and the insufficiently ground portions.

The motor is a horizontal wheel with paddles, which the water reaches through a very long rectilinear and nearly horizontal conduit. The water has a very great velocity, and strikes the paddles and sets the wheel in motion. This wheel, keyed upon the same vertical shaft as the mill above, carries the latter along in its motion.

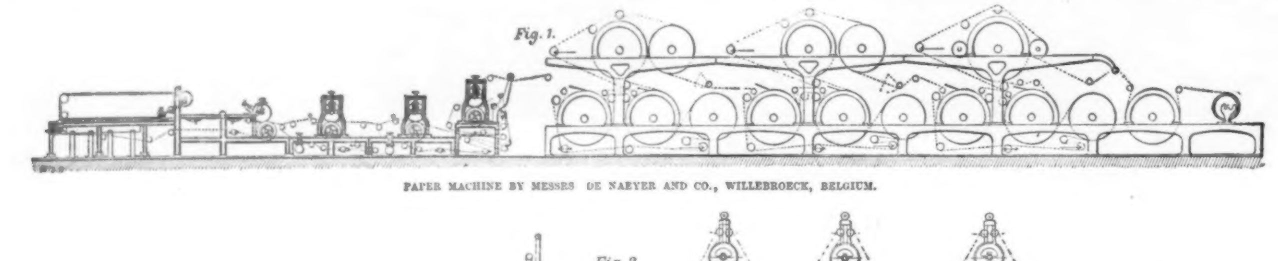
The construction of the motor is very simple. Two rabbeted cross pieces, A and B (Fig. 1, No. 2), form the frame. These are beveled toward the two extremities, so that the boards that cover them may form a nearly

Fig. 1.



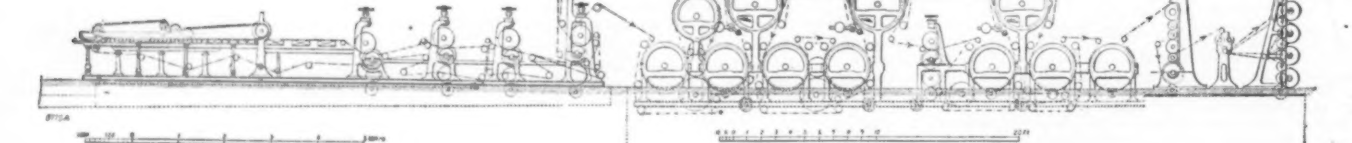
PAPER MACHINE BY MESSRS. DE NAEYER AND CO., WILLEBROECK, BELGIUM.

Fig. 2.



PAPER MACHINE BY MESSRS. DAUTREBANDE AND THIRY, HUY, BELGIUM.

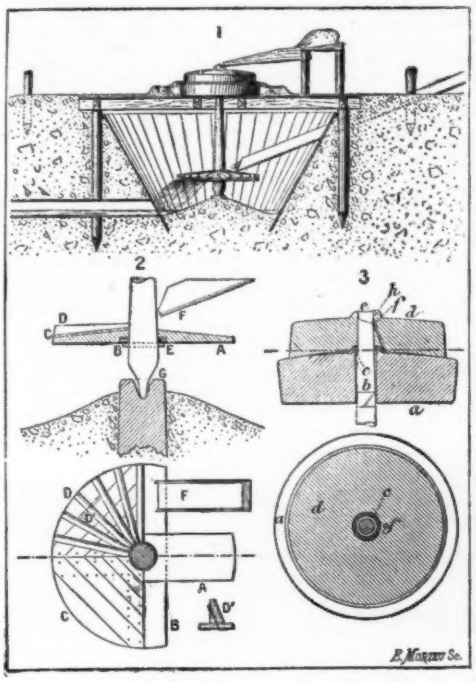
Fig. 3.



PAPER MACHINE BY MESSRS. ESCHER, WYSS, AND CO., ZURICH.

PAPER MACHINES AT THE PARIS EXHIBITION.

regular base approaching a very open cone. Upon this base are fixed the radii or paddles of the wheel, each formed of strips of wood in the shape of a trapezium. The height of each diminishes from the circumference to the center, and the vertical face is so arranged as to receive the current of water led by the conduit, F. The nails that fix the strips to the base, C, are driven into this face in a slightly inclined direction (D').



FIGS. 1-3.—MECHANISM OF AN ALGERIAN FLOUR MILL.

The whole, mounted by hard friction on the shaft, is fixed to the latter by a pin, E, which traverses the shaft and is nailed to the frame. The bottom of the shaft is beveled off and rests in a hardwood bearing held solidly by a foundation made of stones and beaten clay. A little tallow is put into the bearing, G, from time to time to prevent griping.

As for the stones, the arrangement is no less simple. The bedstone, *a* (Fig. 1, No. 3), rests upon a rude wooden frame and is provided with an aperture in the direction of its axis. It is through this that passes the shaft protected by a leather collar, *b*, against the friction that would rapidly wear it away. A collar, *c*, serves also to hold the upper millstone, and especially to prevent the grain from escaping between the shaft and the bedstone. The runner, *d*, is fixed on the shaft by friction, and touches the stone, *a*, only at the periphery.

The grain led by the conduit, *e*, meets the bevel that terminates the head of the shaft, slides into the conduit, *f*, formed in the stone, and comes between the stones. The drilling of the conduit, *f*, constitutes the most delicate part of the work of shaping the stone, and takes quite a long time.

The flour that issues from the mill collects upon a hard clay floor surrounding the bedstone, and is from thence taken and put into bags and left to be bolted afterward, if the purchaser desires it.

The mill is protected from inclement weather merely by a light hut of stakes, dry grass, and unbaked bricks. From time to time when the stones refuse to do service they are again cut. The bevel of the shaft is slightly elongated in order to leave the conduit, *f*, always open.

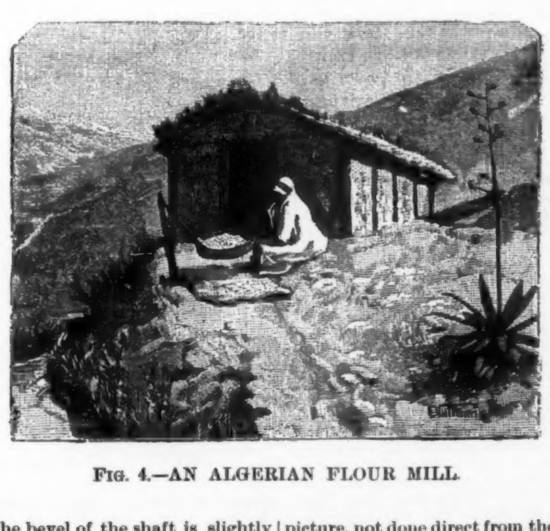


FIG. 4.—AN ALGERIAN FLOUR MILL.

Fig. 4 shows an Arab sifting his flour in front of his mill. As may be seen, the installation is primitive.

The Arab, through laziness, avoids progress. "My father's father did so, my father did the same, why do better?"—*La Nature.*

A NOVEL MEANS OF DISTORTING PHOTO. PICTURES.

A VERY clever definition of photography that we once met with in the course of our reading made our art "the art of delineating aspects scientifically." This covers the ground very well, in fact we have never seen anything better. If we take the word "scientifically" in a free and liberal sense here, we might make it refer not only to true and faithful reproductions of objects, but to such scientific delineations of those objects as would tend either to the exaggeration of their beautiful qualities or to the suppression of their ugly ones.

It is not our purpose to repeat in this connection any of the unctuous art jargon concerning "truth in art," etc., which occupies by far too much space in the columns of our photographic literature, but rather to ask our readers to consider the merits of the following curious process, which at first might be regarded in the light of a caricature only.

Transformism, the process alluded to, is defined by M. Ducos du Hauron rather diffusely as follows: "An image, characterized by a change in the relative proportions of the objects represented, is formed if a ray of light be introduced into a dark chamber, not through a simple orifice, but through two slits cut in places which are differently directed, and separated by a proper distance." He then proceeds to give some examples which are startling, to say the least. It seems that when the first of the two slits is vertical and the second (the one nearest the image) horizontal, the image, when compared with the original, will be found to be amplified or stretched vertically. Again, if one of the two slits, instead of being rectilinear, be curved more or less, the image will show curves or undulations laterally or vertically according to the direction of the slit. The examples therewith given are at least as strange and uncanny as the former ones. All the examples given are portraits, and here is the point that is so surprising—the natural likeness is well preserved in spite of the extreme distortion. The distortion of countenance seen in a convex mirror in some measure approaches to it, but it is not the same.

The method of working adopted by M. Du Hauron is quite simple, and we will here give a condensed account of it, premising that for certain unfortunate individuals possessing great facial deformities this process may prove valuable, the photographer having it in his power to greatly exaggerate certain features and to suppress others. It is this point to which we desire to direct our readers' attention, that the process called "transformism," for want of any better name, puts into their hands the possibility of altering the features of the sitter, and yet of preserving the likeness while doing so. A sitter with a head so flat and wide as to be unsightly would be a good subject for trial with the first slit vertical and the second horizontal, as we mentioned above. Other examples will suggest themselves. M. Du Hauron gives the following directions: "The best means of experimenting with photographic transformism is to provide a dark box so fitted up that twelve or more proofs may be made at one operation. Two partitions or septa are set into a deep frame, opposite to each other and to the sensitive surface at the bottom of the frame, the model being at the other end of the box and well lighted. Each of these two septa is pierced with twelve or more slits, which are brought opposite to each other and disposed in symmetrical rows. Two slits of any given form are then so placed that the desired deformation or distortion may be produced. The model will then be represented by as many different "transformisms" as there are pairs of slits. In the production of these images the slight distance separating the slits from the sensitive surface will greatly influence the action of the light, so that the exposure will remain within the limits absolutely practicable for portraiture. The proofs obtained will thus all differ the one from the other. A variety may be made by reversing the position of either one, or both, of the two septa above mentioned, turning them upside down, etc. If a camera furnished with a battery of lenses of any desirable number were at hand, a plate of instantaneous proof types might be made, with the same distances between as between the slits in the septa. This plate could then be set in place before the slitted septa in the dark box, and thus a series of instantaneous portrait transformisms obtained."

It is evident from the above description that the transformism is made from a ready-made portrait or picture, not done direct from the sitter. There are certain points in the process analogous to the pin hole or diffraction principle of making views. Fun and recreation can be had from the above in plenty; but it is rather as an important means by which defects may be remedied in portraiture that we recommend it to all of our readers who are willing to experiment out of the beaten track.

In concluding let us add that the making of the slits requires care; they should not be broader than one-third of a millimeter. They should be drawn on white paper with India ink, rather large in size, and with clean edges and borders, then reduced to the desired measure by means of the camera. The negative, of course, must be on glass, and acts as the transforming screen.—*Ellerslie Wallace, British Journal.*

PLATINOTYPE PRINTING.*

BEFORE proceeding to give you a practical demonstration of the platinotype processes, I think it will be advisable, for the sake of those present who may not have worked either of them, to make a few remarks respecting the mode of procedure in each of the two processes, the hot bath and the cold bath.

We will take the hot bath process first, as being the one most in use at the present time, and which, I believe, gives the best results if the negatives are really good ones.

To get the best results with platinotype, the negative must be fully exposed, so as to get detail and delicate gradation in every part, the deepest shadows being represented by perfectly clear glass and the high lights fairly dense. It is hopeless to try to obtain a good platinum print from an under-exposed and hard negative. A fair silver print may be often made from a negative which would not yield one worth looking at if printed in platinotype. With a good negative to print from there is no other process which will yield such beautiful and artistic results as platinotype.

The paper is sent out in sealed tins containing two dozen sheets, cut to the various sizes of photographic plates; or it may be obtained in large sheets 26×20, and cut up as required. It is most convenient to buy it ready cut up, as it saves trouble, prevents soiling the paper by fingering it too often, and a smaller calcium tube for storing it will suffice. The Platinotype Company, in their directions, recommend you to place it at once in the calcium tube, as soon as you open the tin, but I have generally left it in the tin as received, and placed an India rubber band round the edge of the lid so as to exclude all air, and I have found it to answer perfectly, having kept paper in good condition for four months in that way. The greatest care must be taken with platinotype paper to guard it from the slightest dampness, as if the least damp it will not yield bright, "juicy" prints. You will get nothing but dull, mealy pictures, showing a very granular deposit of platinum.

The sensitized paper before exposure is of a lemon yellow color. During exposure, the parts affected by light become of a pale, grayish brown, and finally, if the negative be fairly vigorous, of a dull, orange tint under those parts of the negative which present clear glass. When this last change has taken place it indicates that the iron salt has been almost completely reduced, and then further action of the light produces no more visible effect on such parts. The correct exposure (about one-third of that required for a silver print) is ascertained by the inspection of the paper in a weak white light in the usual manner. Judging the correct exposure is, for the beginner, the most difficult part of platinotype printing. Nothing but practice in this case can make perfect. As a rule, printing should be continued until nearly all the details are *just* visible. The appearance of the undeveloped print, however, varies very much with the different kinds of negatives used.

Development should be conducted in a feeble white light or by gaslight. It may be proceeded with immediately after the print is exposed, or, more conveniently, at the end of the day's printing, when the various prints may be sorted and treated as their appearance may dictate. The developer is made by dissolving 130 grains of oxalate of potash in one ounce of water. One pound of oxalate of potash to fifty-four ounces of water is sufficiently accurate.

For general work a weaker solution must not be used. The bath must not be acid. If it is found to be acid, add a very little carbonate of potash until neutral to test paper. The bath can be used over and over again, so long as it yields good results. The solution used to-night has been in use for the last three months, a little fresh solution being added occasionally to make up the bulk. A temperature varying between 140° and 160° Fahr. may be considered the best standard temperature for the developer, though higher and lower temperatures may be used to correct slight under or over exposure.

There is, however, with the hot bath process very slight latitude allowable in the exposure. For under-exposure, the temperature may be raised up to 180°, and an over-exposed print may sometimes be saved by using a weak bath at about 80° to 100° Fahr. It is much more satisfactory to make another print of correct exposure than to attempt to "doctor" a wrongly exposed one; the over-exposed ones especially are always coarse and granular, and will never give satisfaction when finished.

The print is usually floated on the top of the developing solution, but I prefer to immerse it by quickly sliding it under the surface of the developer, as in that way air bubbles are more easily prevented. In floating the paper quickly it is very difficult to prevent the formation of a few air bubbles underneath it; and although, if the print be raised from the solution and again floated on it, they do not show very much, still there is generally a slight difference of tint where the air bubbles have been, which, if it happens in the delicate half tones of a face, is very annoying. They very rarely happen when the paper is immersed, and the resulting print is quite as good.

Let the print stay under for five or six seconds, then raise it and see if it be developed enough; if not, immerse it again for a few seconds, until the complete reduction of the platinum salt has taken place. Take the print direct from the developer and place it face downward in the acid bath, which is made by adding one ounce hydrochloric acid to sixty ounces of water. The object of this acid bath is to dissolve out of the paper all the iron salts, which, if they remain in, would cause the print to assume a yellow tint. The prints must have at least three changes (of five to ten minutes each) of the acid bath, so as to remove every trace of iron.

They should not communicate to the last acid bath the slightest tinge of color. After the prints have

*Communication to the Cheltenham Photographic Society.

passed through the acid baths they must be well washed in three or four changes of water for about fifteen minutes. They are then finished, and as soon as dry are ready for mounting. The prints may be dried either between clean blotting paper or may be hung up by clips in a warm place. For mounting I find a good thick starch paste answers perfectly.

COLD BATH PROCESS.

In this process the paper contains only iron salts, the platinum being in the developing solution, which is applied cold, either by floating the print on it, as in the hot bath process, or by applying it with a broad camel hair brush.

There is undoubtedly more latitude of exposure in the cold than in the hot bath process, and also the results are more under control, and may be modified to a greater extent. For instance, with it a very thin negative may be made to give a brilliant print by giving only the minimum of exposure and using a developer strong in the platinum salts; whereas, with the hot bath process, only a very soft, delicate print could be obtained. And, again, a dense negative inclined to hardness may be made to give a much softer print with the cold than with the hot bath process. The paper must be fully printed and developed in a solution weak in platinum, so as to allow the half tones to come up more equally with the shadows than they would with the hot bath process.

In the divided picture I now show you, you will see the effect of using the developer with different proportions of the platinum salt. The picture was printed in the usual manner, and the print cut in two. One piece was then brushed over with the developer as recommended by the Platinotype Company, viz., one part platinum solution to five parts Dilute D. The other piece was developed with only half the quantity of the platinum solution.

The deep shadows of the first half of the picture you will notice are blacker and more brilliant than those of the second half, the second half being much softer and the gradations more gradual than in the first. The effect could have been much more pronounced if the development of the first piece had not been continued so long, as the deep shadows had attained their present density some time before the half tones had arrived at their present tint. By stopping the development sooner, as I will show you presently, a much more brilliant effect could have been obtained.

The cold bath paper must be damped either before printing or just before development; before printing is said to give the best results. To damp the paper, spread the pieces on a clean sheet of paper in a darkened room until they have lost their crispness, but not long enough to make them *limp;* fifteen minutes is usually sufficient.

Light produces a more visible image on dry paper than on damp. It is therefore easier to expose dry and damp afterward. The exposure required is rather less than in the hot bath process, and is conducted in the same manner.

DEVELOPING FORMULA.

Dissolve half "developing salts" in fifty ounces of water and label "D."

Take sol. D.... 3 parts. } Label this sol. "Diluted D."
" water.... 2 " }

Dissolve sixty grains "platinum salt" in two ounces of water and label "P."

The normal developer given in the instructions is made by adding one part P to five parts Diluted D; but for ordinary work I prefer to use it with one part P to eight or ten parts of Diluted D, the development being much more under control with this than with the stronger solution. To develop by floating, put enough solution into a clean porcelain dish to well cover the bottom. Float the print on the developer for one or two seconds with its printed surface downward; then raise it, again float it and raise it. Now hold it in the hands, face upward, and watch the progress of development. Immediately the right strength and effect are gained, immerse the print in the acid bath as in the hot bath process. Prints with strong shadows may require to be floated and raised several times in order to supply sufficient platinum from the developer.

DEVELOPMENT BY BRUSH.

If only a few prints are to be developed, it is more economical to mix a small quantity of developer and apply with a broad camel hair brush. The brush must be well wetted with developer, and used with a rapid motion, and it must be redipped after every second stroke. Commence the strokes at one edge of the print and let each overlap the previous one. Immediately the print is covered give another series of strokes at right angles to the first. The treatment with the acid baths and the subsequent washing is exactly the same as described in the hot bath process. For more minute details in the working I must refer you to the instructions sent out with the different papers.

In conclusion, I would strongly advise all amateurs who aim at producing really artistic results to try platinotype. The practical working of it is much more simple and more quickly accomplished than any other method of printing. There is no toning bath to get out of order and obstinately refuse to impart to your prints any other tone than a nasty brick red; no hypo to be eliminated only by long, continuous washing; and last, but not least in value, is the knowledge that your pictures, when made, will not be liable to fade and do you discredit, but will be things of beauty, practically, forever.—*W. C. Beetham, reported in the Br. Jour. of Photo.*

PHOTOGRAPHING THE HANDS.

We owe a new and interesting application of photography to M. Bertillon, the well known director of the identification department at the Paris Prefecture of Police. M. Bertillon has been devoting himself for some months to the study of the physical peculiarities engendered by the pursuit of different occupations. The police have frequently to deal with portions of bodies, and it would greatly aid their investigations to be able to determine the calling of the murdered person in each particular case. The hand is, as a rule, the part naturally most affected by the occupation, and M. Bertillon has taken a very large series of photographs, each one showing on a large scale the hands, on a smaller scale the whole figure of the workman at his work, so that one may see at a glance the position of the body, and which are the parts that undergo friction from the tools in use.

From the hands of the navvy all the secondary lines disappear, and a peculiar callosity is developed where the spade handle rubs against the hand; the hands of tin plate workers are covered with little crevasses produced by the acids employed; the hands of lace makers are smooth, but they have blisters full of serum on the back and callosities on the front part of the shoulder, due to the friction of the straps of the loom; the thumb and the first joints of the index of metal workers show very large blisters, while the left hand has scars made by the sharp fragments of metal. Experts in forensic medicine (Vernois among others) have before drawn attention to the subject, but this is the first time that an investigation has been carried out on a large scale, and in M. Bertillon's hands it should lead to the best results.—*Nature.*

[Continued from Supplement, No. 738, page 11794.]

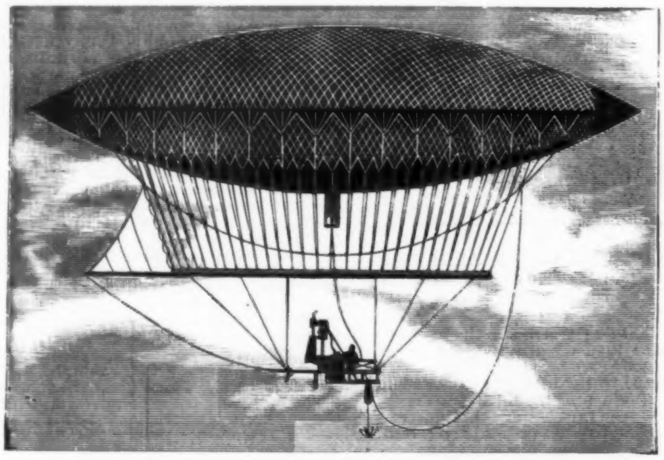
SIBLEY COLLEGE LECTURES.—1889-90.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

II.—The History of Aeronautics.

By Prof. W. Le Conte Stevens, of Brooklyn, N. Y.

Reference has already been made to the fruitless efforts of Robert, Blanchard, and others, to steer balloons by the use of oars and sails. The great hopes born of enthusiasm were dashed, and in time ridicule was directed against the art that had been so popular. The futile attempts to direct balloons were made the subject of caricature, and for half a century nothing effectual was accomplished in the development of aerial navigation out of what was thus far nothing more than aerial drifting. The balloon is immersed completely in the medium through which it must travel, and the problem of directing it is different from that of steering a body only partly submerged, like a ship on the bosom of the ocean.



GIFFARD'S AERIAL STEAMER.

Probably the first intelligent suggestion offered in regard to the directing of balloons was written by Francis Hopkinson to Benjamin Franklin. In a letter dated at Philadelphia, May 24, 1784, he recommends that the balloon shall be made oblong instead of spherical, and provided with a large and light wheel at the stern. "This wheel should consist of many vanes or fans of canvas, whose planes should be considerably inclined with respect to the plane of its motion, exactly like the wheel of a smoke jack. If the navigator turns this wheel swiftly round by means of a winch, there is no doubt but it would, in a calm at least, give the machine a progressive motion, upon the same principle that a boat is *sculled* through the water." (Sparks' "Life and Works of Benjamin Franklin," vol. x., p. 93.) This remarkable suggestion by Hopkinson shows that he had quite definite views about the application of the principle of the screw propeller to the direction of aerostatic machines, though in his day screw propellers had not yet been applied even to surface navigation. His suggestion did not then find its way into print, and, even had it been published, the means were wanting for any experiments on a large scale. Nearly seventy years elapsed before his idea, independently evolved by another, was put to the test.

In 1852 the idea of applying steam to the propulsion of balloons was put to the test by Giffard, a young engineer, who subsequently won the highest distinction. He is perhaps best known to the American public in connection with the Giffard injector for supplying water to steam engine boilers. He constructed an elongated balloon, pointed at each end, which was filled with illuminating gas. Its length was 132 feet, its capacity 75,000 cubic feet. The extremities of the netting which covered it were joined to cords that sustained a longitudinal shaft about 60 feet in length. This carried at the rear end a triangular sail, which could be turned about an almost vertical axis and be made to serve the purpose of a rudder. About 20 feet below the shaft hung a wooden platform on which rested the steering apparatus, consisting of a steam engine and a two-bladed screw propeller. The boiler was vertical, without tubes, and enveloped in cloth. The chimney pipe pointed downward, in order to diminish the danger from sparks. The draught in this pipe was effected by means of the steam which issued at the exhaust of the cylinder, mingling with the smoke, tending to propel the machine by reaction of the air, and thus serving as an adjunct to the fan of the propeller. Coke was employed as fuel in the furnace, which was completely surrounded by a fender. On each side was a receptacle, one for fuel and the other for water; the latter forced into the boiler by means of a pump moved by the piston rod. The weight of the machine, including balloon, netting, shaft, ropes, platform, engine and boiler, with the contained water and fuel, etc., besides the aeronaut, was not quite 3,600 pounds.

In this aerial steamer Giffard ascended from the Hippodrome in Paris, on the afternoon of September 25th, 1852, to a height of nearly 5,000 feet. The wind was blowing too strongly for him to struggle directly against it, but he was able to make very perceptible headway obliquely, and by the aid of the rudder to turn the machine in any desired direction. The descent was safely accomplished before nightfall.

This experiment showed that the problem of aerial navigation, which had baffled so many aeronauts, was by no means insoluble, if a vessel of proper form were driven by means of proper appliances, using a motor more powerful than that of human muscle. The large surface opposed to the air by a spherical balloon insures great waste of power in overcoming resistances. The mechanical effect obtainable with Giffard's apparatus was equivalent to that of more than twenty men; and the proper motion given to his balloon was estimated as five or six miles per hour.

He repeated his experiment in 1855, but under unfavorable conditions. The danger of maintaining a steam engine, sending forth occasional sparks, in the immediate proximity of many thousand cubic feet of inflammable gas contained within an envelope of thin cloth, would be enough to cool the ardor of most men, especially after a lofty elevation is reached.

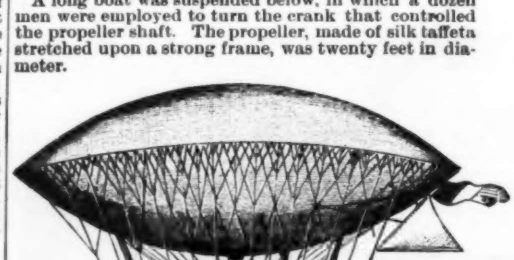
Despite this fact, an arrangement was entered into with Giffard to make ten or a dozen ascensions with his steam balloon. Its non-fulfillment was attributed to the inability of the gas company to supply the necessary means of inflation.

Another source of trouble in using this type of aerostat is that the continual ejection of spent steam and of the products of combustion makes it difficult to preserve the proper relation between ascensive power and weight to be sustained. Whatever may be the reason, or combination of reasons, Giffard abandoned his experiments in steam locomotion through the air.

Twenty years elapsed after Giffard's initial experiments before the problem was again attacked practically by his countryman, M. Dupuy de Lome, who had received an appropriation of money from the government for the prosecution of his design.

His balloon was nearly similar in form to that of his predecessor, 130 feet long, and with a capacity of 120,000 cubic feet. It was inflated with hydrogen, and had a lifting force of more than four tons.

A long boat was suspended below, in which a dozen men were employed to turn the crank that controlled the propeller shaft. The propeller, made of silk taffeta stretched upon a strong frame, was twenty feet in diameter.



DUPUY DE LOME'S BALLOON.

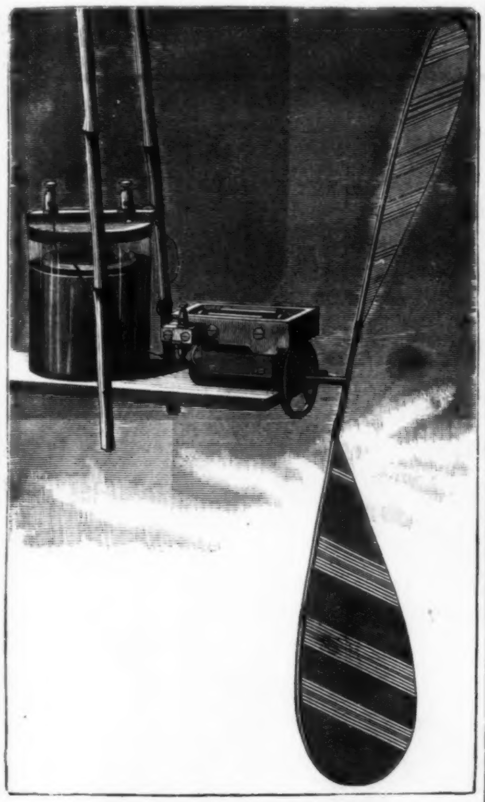
Dupuy de Lome ascended in this balloon on the 2d of February, 1872, and attained a speed estimated at about six miles an hour. By means of a rudder he changed the direction through an angle of 12°. These results were no better than those of Giffard, while the cost of construction was far greater. Muscular power was too uneconomical, while steam was too dangerous to be employed in the direction of aerostats.

In December of 1872, a German civil engineer, Hänlein, constructed a balloon 166 feet in length, with

cubic capacity rather more than two-thirds that of the French balloon, and form much more elongated. He made a trial trip of one hour in it at Brünn. It was filled with illuminating gas and the motive power was a gas engine, which took its supply of explosive material from the balloon above. Hänlein attained a speed varying from ten to twenty miles per hour. An improvement in his gas engine was subsequently made, but there is no record of any repetition of his experiment.

It was not until 1881, the year of Giffard's death, that electricity was applied as a motive power in the attempt to solve the problem with which he had grappled. His pupil, M. Gaston Tissandier, had early imbibed a passion for aeronautics, and made many successful ascents with spherical balloons. He conceived the idea of applying the storage battery as a source of energy, and constructed a small experimental balloon which was filled with hydrogen, its effective ascensional force being less than five pounds. A motor of the Siemens type, weighing less than half a pound, was made to turn the propeller, which consisted of a pair of vanes, each four inches long. The storage cell, motor, and propeller were supported on a light platform suspended by netting. This little aerostat was exhibited at the Electrical Exposition of 1881, and a bronze medal awarded its inventor. It attained a speed of about three meters per second, equivalent to rather more than six miles per hour.

Encouraged by this success, Tissandier undertook the work of constructing an aerostat large enough to lift several persons in addition to the weight of the propelling apparatus and other accessories. The task was one which involved a heavy expenditure of money, aside from the time, labor, and thought bestowed by the inventor. He sought in vain to organize a com-



TISSANDIER'S MODEL, 1881.

pany with a capital of 200,000 francs for the purpose of constructing an aerostat of 300,000 cubic meters capacity; but the plan was not attractive to investors. No one but his brother, M. Albert Tissandier, could be found confident enough to join him in laying out capital for what business men were disposed to regard as a visionary scheme.

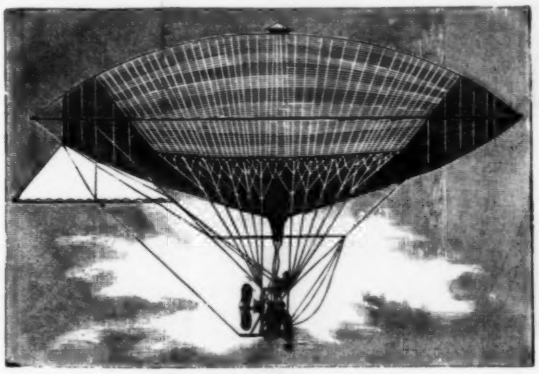
The two brothers henceforward worked together, the one continuing to devote himself to the perfection of the electrical appliances on which reliance was to be placed, while the other, an architect by profession, gave his attention to the mechanical construction of the aerostat.

M. Gaston Tissandier had found by experiments with his small aerostat that better results were to be had from a battery of cells, arranged in series, where a strong solution of potassium bichromate was the exciting liquid, than from a storage battery, the energy evolved during the first few hours being greater in proportion to the weight of the battery. He originated several ingenious contrivances by which great lightness was secured, and the liquid could be conveniently brought into contact with the zinc and carbon plates, or removed at will without disturbing the plates.

A Siemens electric motor was constructed, weighing but 121 pounds. When excited by the current from a battery of 24 elements weighing 370 pounds, this motor was found capable of doing work equivalent to that of twelve or fifteen men, that is, from 600 to 700 foot pounds per second, or considerably more than one horse power, while the weight of battery and motor together was but little in excess of the weight of three men. The effective life of the battery while yielding this amount of energy was about three hours.

Tissandier devised also important improvements in the method of generating pure hydrogen rapidly on a large scale. The ascensive force of this gas when pure is about 75 pounds per 1,000 cubic feet, while that of coal gas, which has been most generally employed for ballooning purposes, is not more than five-eighths as much. By the substitution of hydrogen, the size, and consequently the expense, of the balloon is correspondingly diminished.

The aerostat constructed by M. Albert Tissandier was 92 feet long, 30 feet in its greatest diameter, with a capacity of about 38,000 cubic feet, and ascensive power of 2,800 pounds. The propeller, 9 feet in diameter, was in the rear of the suspended cage. Above



TISSANDIER'S BALLOON.

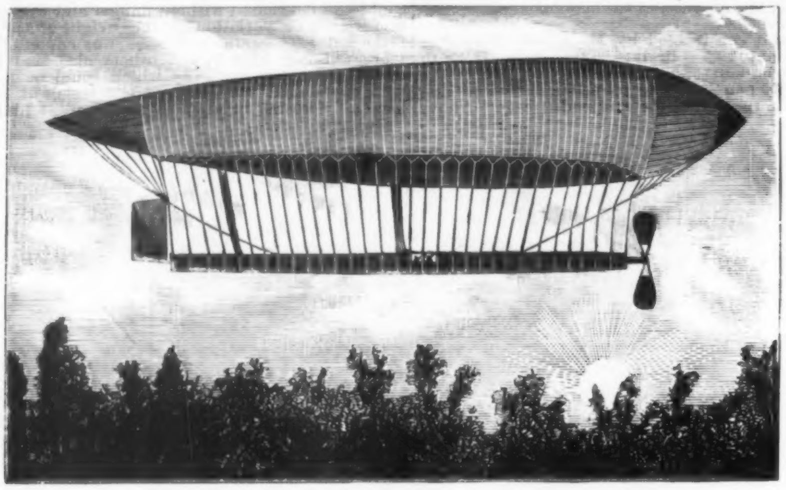
it, and farther back, was a triangular sail, to be manipulated as a rudder.

On October 8, 1883, the first ascent was made. The air at the ground was calm, but when a height of 1,600 feet was reached, the wind was blowing at a rate of rather more than six miles an hour. On putting the propeller into action, with a velocity of three revolutions per second, and turning the head of the aerostat against the breeze, it was kept motionless for some minutes; but the rudder soon proved to be insufficient to keep the direction constant. It flapped like a sail, and at times left the two aeronauts at the mercy of the wind. After stopping the propeller and waiting until the direction of the aerostat coincided with that of the wind, the action was renewed. A marked acceleration in speed was the immediate result, and deviations from the line of the wind were secured by very slight motion of the rudder, the aerostat keeping its stability perfectly. The descent was safely accomplished after remaining in the air a little more than an hour.

This first experiment in the use of electricity in practical aeronautics was about as successful as that of Giffard with steam in 1852, so far as relates to the attainment of speed; but it showed that such speed could now be secured without danger and without any uncontrollable variation in the weight of the object propelled. Tissandier's success was enough to convince, not only himself, but others also, that he had opened out a new pathway which could be followed with confidence. He had not the means at hand to keep his aerostat inflated, so as to repeat his experiment on the first favorable day after imposing such modifications as were suggested by the experience of the first ascent. It was not until September 26, 1884, that this opportunity was presented. The velocity of the wind was about the same as during the first ascent, but the aerostat was propelled at a rate about one-third greater, so as to make at times very perceptible headway against the wind.

Meanwhile the success attained by the Tissandier brothers in 1881 and 1883 had inspired MM. Renard and Krebs, officers of the French army, who were stationed at Chalais-Meudon, near Paris. They had for several years been conducting experiments on the conditions requisite for directing balloons, being guided in their studies by the previous work of Dupuy de Lome. An appropriation of 100,000 francs had been granted them by the government, and their investigations were conducted with the utmost secrecy, for the purpose of applying their results to military purposes. The pecuniary resources at their command gave them a great advantage over Tissandier, in the ability to construct a balloon much larger than that with which his success had been attained; and this permitted the application

TISSANDIER'S CAR.



RENARD & KREBS' BALLOON.

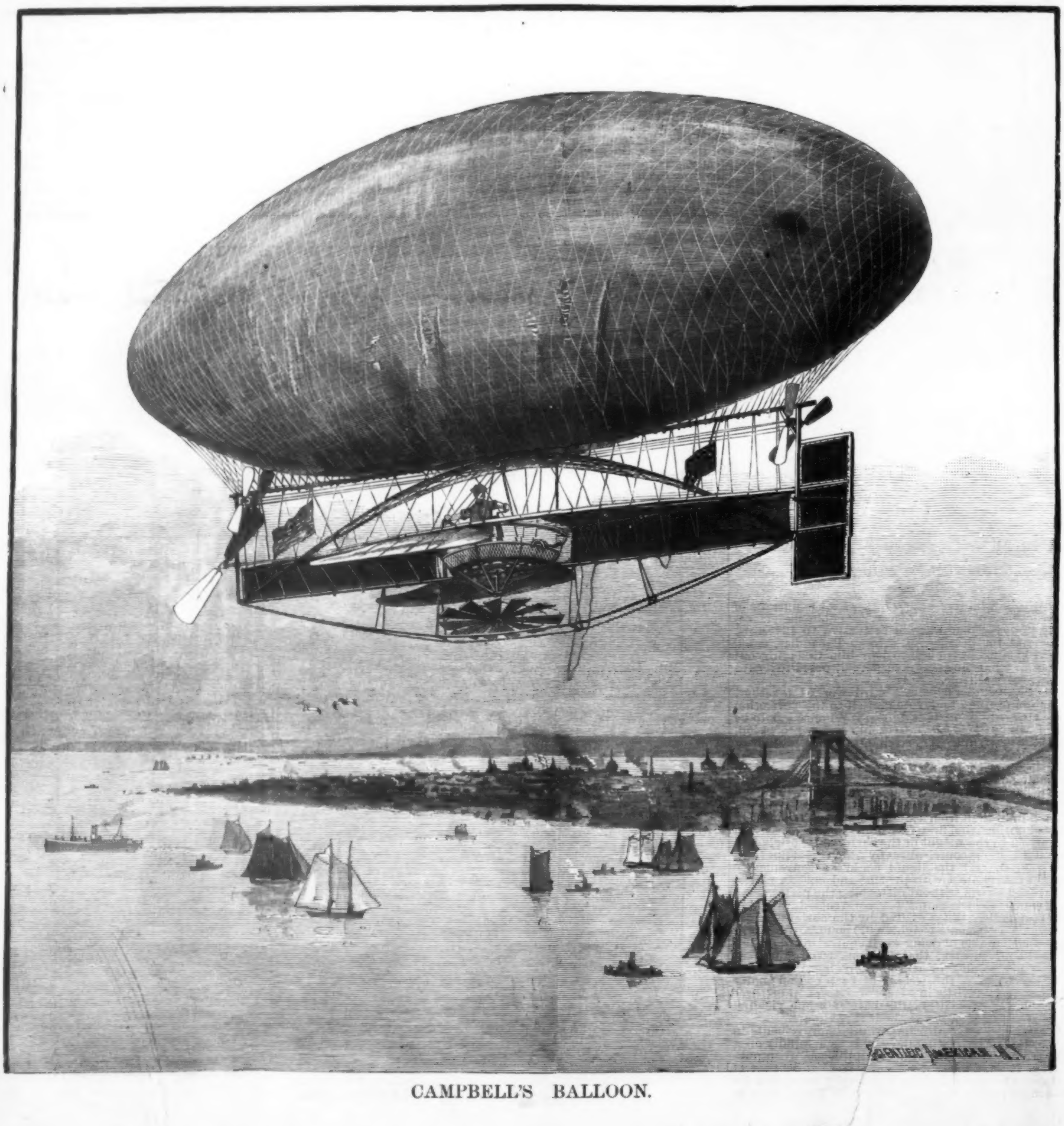
of a motor about eight times as powerful as Tissandier's. Their balloon was 166 feet long, 28 feet in its greatest diameter, 67,000 cubic feet in capacity, and had an ascentional power of nearly 5,000 pounds. The ratio of length to thickness is thus much greater than in Tissandier's balloon. The details of construction of the battery and motor have been withheld from the public, but it is scarcely possible that they can include any important principle not now well known to electrical engineers. The rudder was almost a parallelogram in form and thickness at the middle, the cloth being tightly stretched over a light framework, so as to present a rigid surface to the air.

The propeller was fixed to the extremity of a long shaft and placed at the front, instead of rear, of the balloon. The front end, moreover, was thicker than the rear end. The balloon was filled with hydrogen. To assist in making it ascend or descend, recourse was had to a device employed by Dupuy de Lome, that of a small balloon within the large one, connected by a tube with the cage, where air could be pumped in or out at pleasure, thus varying slightly the specific gravity of the mass as a whole.

On August 9, 1884, an ascent was accomplished with this balloon, the atmosphere being almost perfectly calm. A journey of nearly two miles was made in a southerly direction, then over a mile westward, after which the balloon was turned northward and eastward. Very slight motion of the rudder was needed to execute these curves. Twenty-three minutes after their flight was begun the aeronauts were immediately over their starting point, having made a trip of not quite five miles. In descending it was necessary to move backward and forward several times in succession, alternately reversing the direction of rotation of the propeller. The return to the ground was at the very spot from which the departure had been made. This remarkable feat was thus accomplished almost exactly one hundred and one years after the ascent of the first hydrogen balloon, sent up by Charles from a point but a few miles distant.

A second ascent was made by Renard and Krebs on the 12th of September, but with only partial success, in consequence of an accident to the motor. On the 8th of November two successive journeys were taken, the balloon returning each time to its point of departure, and attaining a speed of nearly fifteen miles an hour independently of the wind, which was blowing at the estimated rate of five miles an hour.

In their communication to the French Academy of



CAMPBELL'S BALLOON.

1. Montgolfier fire-balloon. 2. Mrs. Sage, first English Lady aeronaut. 3. Vincent Lunardi, first aerial traveler in England. 4. M. Charles, inventor of the gas balloon. 5. J. P. Blanchard, first crossed the Channel in a balloon, Jan. 7, 1785. 6. Mr. Sadler, first English aeronaut. 7. First ascent from Lyons, Jan. 19, 1784. 8. Mr. Henry Coxwell. 9. Perilous situation of Major Money, July 23, 1785. 10. Balloon mistaken for a monstrous animal by the villagers of Gonesse, near Paris. 11. Mr. Charles Green. 12. Green's night voyage to Nassau. 13. Car of Nadar's balloon, "Le Geant." 14. Mr. Cocking's parachute. 15. The two Montgolfiers. 16. Mr. James Glashier, F. R. S. 17. Pilatre de Rozier, first aeronaut, killed in 1785.

(18.) EXPERIMENTAL FLYING MACHINES.

A. Julian's Aerostat. This machine, made in a model, 25 feet in length, moved by clockwork, succeeded in the experiment made at the Hippodrome at Paris.

B. November, 1851. Aerial scheme of Mr. Helle not yet tried; consisting of a combination of sails and screws, which were to have been moved by the strength of two men.

C. The Aerial ship l'Aigle, of Mr. Lennox. It proved a failure in the Champ de Mars, August, 1834.

D. Flying Balloon made by an engineer named Blanville. It is not explained how these wings were to be used; but it gives the idea of weighting and lightening a balloon with air by means of a pump.

E. Systeme Petin, 1850.

F. An anonymous idea.

G. A balloon with a reversed parachute by M. Henin. This parachute was to slacken the ascent of the balloon, and allow the action of the wind on the sails, thereby guiding it at pleasure.

H. Sir George Cayley's Navigable Balloon, 1825.

I. Samson's Aerostat, furnished with fins made of feathers; like Julien's, a motive power is required.

ILLUSTRATIONS OF THE CENTENARY OF BALLOONING.

Sciences, on the 18th of August, Renard and Krebs accorded to Tissandier the credit of priority in successfully applying electricity to the propulsion of balloons. Tissandier, on the other hand, equally freely accorded to them the credit of making a pronounced success of what had been developed to only a limited extent in his hands on account of the want of funds. To each of the group praise is due for making such decided advance toward the solution of a problem which was theoretically solved long ago, but which involved practical difficulties that seemed almost if not quite insurmountable.

In the following table, prepared by Major Buchholtz, a German engineer, a comparison is given of the distinctive features and the results attained in the aeronautic experiments just described.

been conspicuously headstrong. Detaching the car and steering apparatus from Campbell's balloon, he substituted apparatus of his own device, and ascended from Brooklyn on the 16th of July, 1889. A breeze was blowing from the west, and the ascension was made against the advice of all of Hogan's friends who were present. On attempting to set his propeller wheel into operation, he found this to be out of order, and within a few minutes it fell to the ground. Possibly his valve may have been out of order also, for apparently nothing was done to make the balloon descend. It was wafted out over the Atlantic Ocean, and Mr. Hogan was lost with the balloon.

As a means of locomotion the balloon is scarcely destined to attain any commercial importance, but for military purposes it may yet be far more valuable than it has been in the past. Balloon traveling has generally been nothing more than aerial drifting. Aerial navigation had no existence whatever until elongated balloons came into use, with the application of motive power to the screw propeller in air. Increasing experience will determine the best disposition to be made in relation to a variety of points that are still open to discussion, such as the best methods of reducing resistance and increasing the efficiency of the motor. On the basis of the success already achieved, calculations have been made which indicate that it may be quite possible, at no very distant future time, to construct larger balloons that will travel in calm air at a speed of twenty-five or thirty miles an hour. But the great expense attendant upon their construction and use forbids the idea of competition with railroads or steamships. The high-tension battery which is at present the most available source of energy has an effective life of only a few hours; and, even during this time, the cost of zinc and acid is far in excess of that of coal and water. It is quite possible that more economical methods of generating electricity may be devised in the future. The method which is now most economical is wholly inapplicable to balloons; for a dynamo needs to be driven by steam power, and if this be applied at all to the balloon, it can be utilized best without the medium of the dynamo. The engineering problem is still not quite satisfactorily solved; but it does not seem by any means hopeless. The only hopeless feature is that connected with the popular use of the balloon. For special purposes, where surface locomotion is impossible, and where expenses can be sustained by great corporations or very wealthy individuals, the steerable balloon may yet win for itself an important place. But the mass of mankind, even in dense centers of civilization, with steamboats and elevated railroads to depend upon, will in all likelihood continue their allegiance to Mother Earth, and be content to allow the explorers of the air to run the risk of sharing the fate of Icarus.

MAJOR BUCHHOLTZ'S TABLE.

Name.	Giffard.	Dupuy de Lome.	Haenlein.	Tissandier, 8 Oct., 1883. 25 Sept., 1884.	Renard and Krebs 9 and 12 Sept., 1884.
Length, meters	44	36·12	50·40	28	50·42
Height, meters	12	14·84	9·20	9·20	8·40
Capacity, cubic meters	1600 (about)	3454	2408	1060	1864
Ascending power, kilog	1800	3799	2629	1240	2000
Motor, with accessories	320 kg. } 3u. 350 kg. }	1050 kg. } 8 men' 204 kg. } = 1u.	537 kg., 3·6u.	280 kg., 1·5u.	652 kg., 8·5u.
Diameter of screw, meters	3·4 (mean)	9 (mean)	4·6 (mean)	2·85 (mean)	7 (about mean)
Number of revolutions	110	25–27	90–180	120	46
Velocity, meters per second	2–3	2·60	5·20–10	3–5	5·50–9
Total weight, in kilos, per H. P.	600	3000	730	500	235
Weight of motor per H. P.	290	12000	146·4	186	77

The very high value, 12,000, given in Buchholtz's table to the weight of motor per horse power in Dupuy de Lome's experiment is on the assumption that the power of a man at the crank is 6·4 kilogrammeters per second, an estimate that is perhaps too small. But even if this be increased up to 10 kilogrammeters, the result is not far from 8,000, which is so large in comparison with the value 77, obtained in the experiment of Renard and Krebs, that very little inducement is left for any one to attempt again the application of muscular power to balloon propulsion. These figures emphasize the remarkable character of the results more recently attained by an American aeronaut.

Mr. Peter C. Campbell, of Brooklyn, is a jeweler, whose mechanical skill has been applied at various times during the last twenty years or more to the construction of balloons on a small scale. In 1887 he made the model of a steerable balloon, which was exhibited to friends at his place of business. It was filled with hydrogen and propelled by clockwork. He suffered the misfortune of being "interviewed" by a newspaper reporter, a distinctively American calamity, and the result was the publication of rather sensational stories in regard to the expected achievements of the larger balloon which Mr. Campbell had undertaken to build. This balloon was finished in due time, and stored at Coney Island. Mr. Campbell seems not to have been thoroughly posted in regard to the comparison of results attained by his various predecessors in France. Instead of making his balloon pointed at the two ends, he gave it the form of an ellipsoid of revolution. Its length was only 42 feet; greatest diameter, 24 feet; capacity, 15,000 cubic feet; and weight, 150 pounds. When filled with hydrogen, its ascensive power was, therefore, about 1,050 pounds, or 900 pounds to balance the weight of the car, steering apparatus, aeronaut, and ballast. For motive power he depended upon the muscular energy of the single aeronaut. This was not encouraging, in view of Dupuy de Lome's limited success with a larger balloon of better shape and the strength of a dozen men to utilize. Mr. Campbell placed his propeller fan at the rear end of the keel, which was suspended and duly braced beneath the balloon. The rudder, which was very large, was placed at the front end. Two pairs of small propellers were additionally placed at the ends, with their axes at right angles to that of the balloon, to assist in changing its direction. A pair of silk wings were also disposed longitudinally on the two sides for the same purpose. In view of the ready response to the motion of the rudder secured by Tissandier, and Renard and Krebs, these wings and terminal small propellers were worse than useless, serving only to increase the surface of resistance to the air; for no single aeronaut could manage them and at the same time keep the main propeller properly in motion. The car was circular, and through its floor passed a vertical shaft, to which was attached a propeller with twelve vanes. By rotating this, the balloon was to be elevated or depressed. Mr. Campbell did not wish to ascend to any great height, but rather to keep an almost exact adjustment between ascensive power and load, depending upon the central propeller chiefly for any change of elevation.

A trial trip was made with this balloon on the 8th of December, 1888, with Mr. James Allen as aeronaut. The afternoon was exceptionally calm, the faint breeze being from sea toward land. The balloon was inflated with hydrogen and rose to a height of 400 or 500 feet. The motion of the central propeller was then reversed, and the balloon was brought down to the spot from which it had risen. Again the propeller was reversed, and it rose to its previous height. The main terminal propeller was then put into operation, and the balloon was propelled against the breeze, made to describe a circle, directed toward the east end of the island, then back, then northward, and finally landed in safety, after having been in the air about two hours. The total distance traversed during this time was estimated to be ten miles. The mean velocity of five miles an hour was thus not more than a third of that attained by Renard and Krebs in their later experiments, but about equal to that of Dupuy de Lome's giant balloon. The experiment was remarkable as affording the best result thus far attained in balloon propulsion and steering with no motor other than a single human being.

On account of insufficient pecuniary resources, Mr. Campbell was compelled to yield to others a partial interest in his balloon. One of these was E. D. Hogan, a professional aeronaut and a man who seems to have

MAGNETISM.*

By Dr. John Hopkinson.

As old as any part of electrical science is the knowledge that a needle or bar of steel which has been touched with a loadstone will point to the north. Long before the first experiments of Galvani and Volta, the general properties of steel magnets had been observed—how like poles repelled each other, and unlike attracted each other; how the parts of a broken magnet were each complete magnets with a pair of poles. The general character of the earth's magnetism has long been known—that the earth behaves with regard to magnets as though it had two magnetic poles respectively near the rotative poles, and that these poles have a slow secular motion. For many years the earth's magnetism has been the subject of careful study by the most powerful minds. Gauss organized a staff of voluntary observers, and applied his unsurpassed powers of mathematical analysis to obtaining from their results all that could be learned.

The magnetism of iron ships is of so much importance in navigation that a good deal of the time of men of great power has been devoted to its study. It was *the* scientific study of Archibald Smith; and Airy and Thomson have added not a little to our practical knowledge of the disturbance of the compass by the iron of the ship.

Sir W. Thomson, in addition to much valuable practical work on the compass, and experimental work on magnetism, has given the most complete and elegant mathematical theory of the subject.

Of late years the development of the dynamo machine has directed attention to the magnetization of iron from a different point of view, and a very great deal has been done by many workers to ascertain the facts regarding the magnetic properties of iron.

The upshot of these many years of study by practical men interested in the mariner's compass or in dynamo machines by theoretical men interested in looking into the nature of things, is that although we know a great many facts about magnetism, and a great deal about the relation of these facts to each other, we are as ignorant as ever we were as to any reason why the earth is a magnet, as to why its magnetic poles are in slow motion in relation to its substance, or as to why iron, nickel, and cobalt are magnetic, and nothing else, so far as we know, is to any practical extent.

* Recent inaugural address as president of the Institution of Electrical Engineers, London.

In most branches of science, the more facts we know the more fully we recognize a continuity, in virtue of which we see the same property running through all the various forms of matter.

It is not so in magnetism; here the more we know the more remarkably exceptional does the property appear, the less chance does there seem to be of resolving it into anything else.

It seems to me that I cannot better occupy the present occasion than by recalling your attention to, and inviting discussion of, some of those salient properties of magnetism as exhibited by iron, nickel, and cobalt—properties most of them very familiar, but properties which any theory of magnetism must reckon with and explain.

We shall not touch on the great subject of the earth as a magnet—though much has been recently done, particularly by Rucker and Thorpe—but deal simply with magnetism as a property of these three bodies, and consider its natural history, and how it varies with the varying condition of the material.

To fix our ideas, let us consider, then, a ring of uniform section of any convenient area and diameter. Let us suppose this ring to be wound with copper wire, the convolutions being insulated. Over the copper wire let us suppose that a second wire is wound, also insulated, the coils of each wire being arranged as are the coils of any ordinary modern transformer. Let us suppose that the ends of the inner coil, which we will call the secondary coil, are connected to a ballistic galvanometer, and that the ends of the outer coil, called the primary, are connected, through a key for reversing the current, with a battery.

If the current in the primary coil is reversed, the galvanometer needle is observed to receive a sudden or impulsive deflection, indicating that for a short time an electromotive force has been acting on the secondary coil.

If the resistance of the secondary circuit is varied, the sudden deflection of the galvanometer needle varies inversely as the resistance. With constant resistance of the secondary circuit the deflection varies as the number of convolutions in the secondary circuit. If the ring upon which the coils of copper wire are wound is made of wood or glass—or, indeed, of 99 out of every 100 substances which could be proposed—we should find that for a given current in the primary coil the deflection of the galvanometer in the secondary circuit is substantially the same.

The ring may be of copper, of gold, of wood, or glass—it may be solid or it may be hollow—it makes no difference in the deflection of the galvanometer. We find, further, that with the vast majority of substances the deflection of the galvanometer in the secondary circuit is proportional to the current in the primary circuit. If, however, the ring be of soft iron, we find that the conditions are enormously different.

In the first place, the deflections of the galvanometer are very many times as great as if the ring were made of glass, or copper, or wood.

In the second place, the deflections on the galvanometer in the secondary circuit are not proportional to the current in the primary circuit; but as the current in the primary circuit is step by step increased, we find that the galvanometer deflections increase somewhat, as is illustrated in the accompanying curve (Fig. 1), in

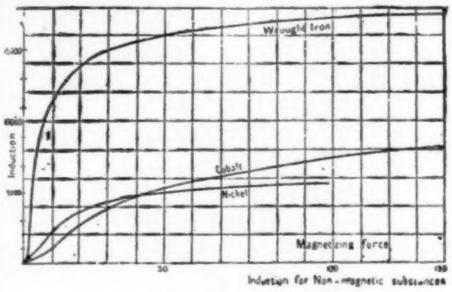


Fig. 1.

which the abscissæ are proportional to the primary current, and the ordinates are proportional to the galvanometer deflections.

You observe that as the primary current is increased the galvanometer deflection increases at first at a certain rate; as the primary current attains a certain value the rate at which the deflection increases therewith is rapidly increased, as shown in the upward turn in the curve. This rate of increase is maintained for a time, but only for a time.

When the primary current attains a certain value the curve bends downward, indicating that the deflections of the galvanometer are now increasing less rapidly as the primary current is increased; if the primary current be still continually increased, the galvanometer deflections increase less and less rapidly.

Now, what I want to particularly impress upon you is the enormous difference which exists between soft iron on the one hand and ordinary substances on the other. On this diagram I have taken the galvanometer deflections to the same scale for iron and for such substances as glass or wood. You see that the deflections in the case of glass or wood, to the same scale, are so small as to be absolutely inappreciable, while the deflection for iron at one point of the curve is something like 2,000 times as great as for non-magnetic substances. This extraordinary property is possessed by only two other substances besides iron—cobalt and nickel. On the same figure are curves showing on the same scale what would be the deflections for cobalt and nickel, taken from Prof. Rowlands' paper. You observe that they show the same general characteristics as iron, but in a rather less degree. Still, it is obvious that these substances may be broadly classed with iron in contradistinction to the great mass of other bodies. On the other hand, diamagnetic bodies belong distinctly to the other class. If the deflection with a non-magnetic ring be unity, that with iron, as already stated, may be as much as 2,000; that with bismuth, the most powerful diamagnetic known, is 0·999825—a quantity differing very little from unity. Note, then, the first fact which any theory of magnet-

ism has to explain is: Iron, nickel, and cobalt, all enormously magnetic; other substances practically non-magnetic. A second fact is: With most bodies the action of the primary current on the secondary circuit is strictly proportional to the primary current; with magnetic bodies it is by no means so.

You will observe that the ordinates in these curves, which are proportional to the kicks or elongations of the galvanometer, are called induction, and that the abscissæ are called magnetizing force. Let us see a little more precisely what we mean by the terms, and what are the units of measurement taken. The elongation of the galvanometer measures an impulsive force—an electromotive force acting for a very short time. Charge a condenser to a known potential, and discharge it through the galvanometer: the needle of the galvanometer will swing aside through a number of divisions proportional to the quantity of electricity in the condenser—that is, to the capacity and the potential. From this we may calculate the quantity of electricity required to give a unit elongation. Multiply this by the actual resistance of the secondary circuit, and we have the impulsive electromotive force in volts and seconds, which will, in the particular secondary circuit, give a unit elongation. We must multiply this by 10^8 to have it in absolute C. G. S. units. Now the induction is the impulsive electromotive force in absolute C. G. S. units divided by the number of secondary coils and by the area of section of the ring in square centimeters. The line integral of magnetizing force is the current in the primary in absolute C. G. S. units—that is, one-tenth of the current in amperes—multiplied by 4 π. The magnetizing force is the line integral divided by the length of the line over which that line integral is distributed. This is, in truth, not exactly the same for all points of the section of the ring—an imperfection so far as it goes in the ring method of experiment. The absolute electromagnet C. G. S. units have been so chosen that if the ring be perfectly non-magnetic, the induction is equal to the magnetizing force. We may refer later to the permeability, as Sir W. Thomson calls it: it is the ratio of the induction to the magnetizing force causing it, and is usually denoted by μ.

There is a further difference between the limited class of magnetic bodies and the great class which are non-magnetic. To show this, we may suppose our experiment with the ring to be varied in one or other of two or three different ways. To fix our ideas, let us suppose that the secondary coil is collected in one part of the ring, which, provided that the number of turns in the secondary is maintained the same, will make no difference in the result in the galvanometer. Let us suppose, further, that the ring is divided so that its parts may be plucked from together, and the secondary coil entirely withdrawn from the ring. If now the primary current have a certain value, and if the ring be plucked apart and the secondary coil withdrawn, we shall find that, whatever be the substance of which the ring is composed, the galvanometer deflection is one-half of what it would have been if the primary current had been reversed. I should perhaps say approximately one-half, as it is not quite strictly the case in some samples of steel, although, broadly speaking, it is one-half. This is natural enough, for the exciting cause is reduced from, let us call it a positive value, to nothing when the secondary coil is withdrawn; it is changed from a positive value to an equal and opposite negative value when the primary current is reduced. Now comes the third characteristic difference between the magnetic bodies and the non-magnetic. Suppose that, instead of plucking the ring apart when the current had a certain value, the current was raised to this value and then gradually diminished to nothing, and that then the ring was plucked apart and the secondary coil withdrawn. If the ring be non-magnetic, we find that there is no deflection of the galvanometer; but, on the other hand, if the ring be of iron, we find a very large deflection, amounting, it may be, to 80 or 90 per cent. of the deflection caused by the withdrawal of the coil when the current had its full value. Whatever be the property that the passing of the primary current has imparted to the iron, it is clear that the iron retains a large part of this property after the current has ceased.

We may push the experiment a stage further. Suppose that the current in the primary is raised to a great value, and is then slowly diminished to a smaller value, and that the ring is opened and the secondary coil withdrawn. With most substances we find that the galvanometer deflection is precisely the same as if the current had been simply raised to its final value. It is not so with iron; the galvanometer deflection depends not alone upon the current at the moment of withdrawal, but on the current to which the ring has been previously subjected. We may then draw another curve (Fig. 2) representing the galvanometer deflections

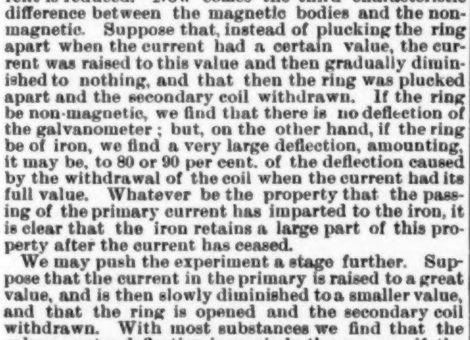


FIG. 2.

produced when the current has been raised to a high value and has been subsequently reduced to a value indicated by the abscissæ. This curve may be properly called a descending curve. In the case of ordinary bodies this curve is a straight line coincident with the straight line of the ascending curve, but for iron is a curve such as is represented in the drawing. You observe that this curve descends to nothing like zero when the current is reduced to zero; and that when the current is not only diminished to zero, but is reversed, the galvanometer deflection only becomes zero when the reversed current has a substantial value. This property possessed by magnetic bodies of retaining that which is impressed upon them by the primary current has been called by Prof. Ewing "hysteresis," or, as similar properties have been observed in quite other connections, "magnetic hysteresis." The name is a good one and has been adopted. Broadly speaking, the induction as measured by the galvanometer deflection is independent of the time during which the successive currents have acted, and depends only upon their magnitude and order of succession. Some recent experiments of Prof. Ewing, however, seem to show a well marked time effect. There are curious features in these experiments which require more elucidation.

It has been pointed out by Warburg, and subsequently by Ewing, that the area of curve 2 is a measure of the quantity of energy expended in changing the magnetism of the mass of iron from that produced by the current in one direction to that produced by the current in the opposite direction and back again. The energy expended with varying amplitude of magnetizing forces has been determined for iron, and also for large magnetizing forces for a considerable variety of samples of steel. Different sorts of iron and steel differ from each other very greatly in this respect. For example, the energy lost in a complete cycle of reversals in a sample of Whitworth's mild steel was about 10,000 ergs per cubic centimeter; in oil-hardened hard steel, it was near 100,000; and in tungsten steel it was near 200,000—a range of variation of 21 to 1. It is of course of the greatest possible importance to keep this quantity low in the case of armatures of dynamos and in that of the cores of transformers. If the armature of a dynamo machine be made of good iron, the loss from hysteresis may easily be less than one per cent.; if, however, to take an extreme case, it were made of tungsten steel, it would readily amount to twenty per cent. In the case of transformers and alternate current dynamo machines, where the number of reversals per second is great, the loss of power by hysteresis of the iron and the consequent heating becomes very important. The loss of power by hysteresis increases more rapidly than does the induction. Hence it is not well in such machines to work the iron to anything like the same intensity of induction as is desirable in ordinary continuous current machines. The quantity, O A, when measured in proper units, as already explained—that is to say, the reversed magnetic force, which just suffices to reduce the induction as measured by the kick on the galvanometer to nothing after the material has been submitted to a very great magnetizing force—is called the "coercive force," giving a definite meaning to a term which has long been used in a somewhat indefinite sense. The quantity is really the important one in judging the magnetism of short permanent magnets. The residual magnetism, O B, is then practically of no interest at all; the magnetic moment depends almost entirely upon the coercive force. The range of magnitude is somewhat greater than in the case of the energy dissipated in a complete reversal. For very soft iron the coercive force is 1·6 C. G. S. units; for tungsten steel, the most suitable material for magnets, it is 51 in the same units. A very good guess may be made of the amount of coercive force in a sample of iron or steel by the form of the ascending curve, determined as I described at first. This is readily seen by inspection of Fig. 3, which shows the curves in the

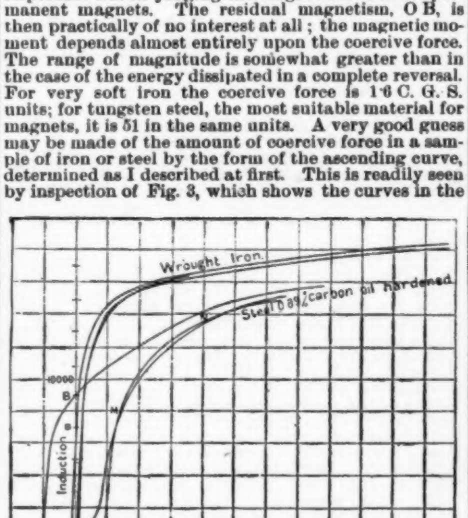


FIG. 3.

cases of wrought iron, and steel containing 0·9 per cent. of carbon. With the wrought iron a rapid ascent of the ascending curve is made, when the magnetizing force is small and the coercive force is small; in the case of the hard steel the ascent of the curve is made with a larger magnetizing current, and the coercive force is large. There is one curious feature shown in the curve for hard steel which may, so far as I know, be observed in all magnetizable substances: the ascending curve twice cuts the descending curve, as at M and N. This peculiarity was, so far as I know, first observed by Prof. G. Wiedemann.

(To be continued.)

THE RENARD PRIMARY BATTERY.

IT would appear that there is a revival of invention in respect of primary batteries, inasmuch as after a silence of about two years in this respect we have within the last two months or so recorded the particulars of two new batteries, and we now do so in respect of a third.

This last is the invention of Major Renard, a French officer, who attracted attention with his battery in his own country during the Paris exhibition.

This battery, which we recently inspected at Messrs. Aron's offices, Bridewell Place, London, has for its electrodes platinum, silvered by lamination, and zinc. The exciter is a solution of chromic acid, hydrochloric acid, and sulphuric acid.

A battery, 2 ft. 9 in. high and 12 in. in diameter over all, weighs 25 pounds when charged, and is said to afford a glow light of from 20 to 25 candle power for from five to eight hours without replenishing the battery, the cost of each charge of the solution being 2s. The current produced is stated to be of 10 volts, 4 amperes, and 45 watts.

The special feature of this battery appears to be the method of working it. The electrodes are placed in tubular cells, which reach to the bottom of the battery and which are open at their lower ends. The elements themselves reach only half way down these tubes, and the exciting solution only reaches half way up them. Hence, in their normal position the electrodes are out of reach of the solution, and there can be no current produced; consequently no waste is going on. To start, the light air is forced into the body of the battery by a small hand pump, and the compressed air impinging on the surface of the solution forces it upward into the tubular cells, and it thus surrounds the electrodes. The greater the compression given to the air, the brighter the light, in consequence of the electrodes being more deeply immersed in the fluid, and therefore producing a greater current. If it is desired to diminish the amount of light, a small valve is opened, and the air pressure is thus reduced, which causes the level of the fluid to become lowered. To extinguish the light the valve is fully opened until the air pressure inside the battery is the same as that outside. It is stated that this battery has earned a good reputation in France, where it is being adopted by the military and naval authorities. By means of larger batteries than that we inspected, it is stated that are lamps of 300 candle power are run with satisfactory results.—*London Times.*

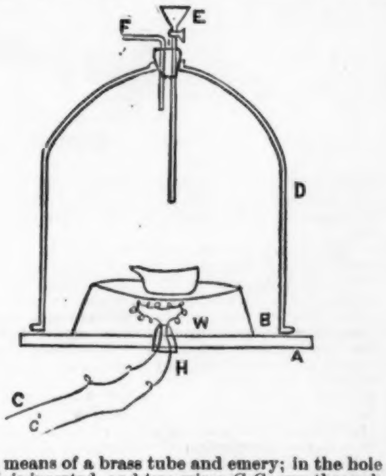
ELECTRICITY IN CHEMICAL MANIPULATIONS.

By REGINALD FESSENDEN, Chemist, Edison Laboratory, Orange, New Jersey.

A DESCRIPTION of a few pieces of chemical apparatus in which electricity is employed may be of interest.

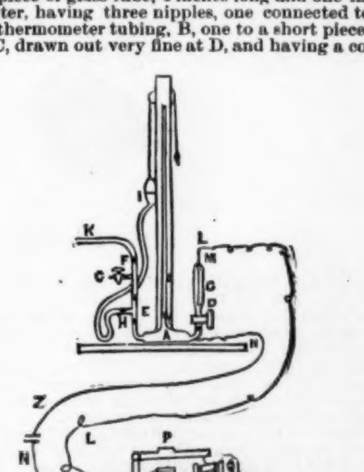
The current is derived from a simple primary battery, such as described above.

1. *For Rapid Evaporation in Vacuum.*—A is a piece of plate glass, through the center of which a hole is



bored by means of a brass tube and emery; in the hole a cork, H, is inserted, and two wires, G G, run through it, each connected to one end of the platinum loop, W, which latter is packed with magnesia or any such material. The operation is as follows: The dish, C, containing the substance to be evaporated, is placed on the stand, B, and the bell jar placed over all. The tube, F, is connected to the filter pump, and the wires, G G, to the terminals of the battery. Evaporation proceeds with extreme rapidity. More liquid is added from time to time through the separatory funnel, E. Where the current is obtainable, electric incandescent lamps may be used, in place of wire, with advantage.

2. *Automatic Heat Regulator and Air Thermometer.*—A is a piece of glass tube, 4 inches long and one inch in diameter, having three nipples, one connected to a piece of thermometer tubing, B, one to a short piece of tubing, C, drawn out very fine at D, and having a cock



at its lower extremity, and the third to the T-piece, E. K is a tube connecting with the air bulb, which may be of Bohemian glass; I is a bottle of mercury, connecting by a rubber tube with H; N is a platinum wire, fused into A; M is a thin carbon rod, resting on the capillary portion of C, and connected to the wire, L. There are cocks at H and T. O is an electromagnet, connected to the wires, L and M. Q is a plunger, held up by a spring in a piston, so that the gas can pass freely through the opening, R, to the burners so long as the magnet is not acting. The operation is

as follows: Cocks, H and T, open, cocks, G and D, shut; it is a simple air thermometer, readings being taken on the tube, D. To use it as a regulator, the bath is raised to the required temperature, cocks, G and D, are opened, and the mercury adjusted so that it nearly touches the carbon rod, M. Cocks, G, H, and T, are then closed. It will be seen that if the temperature rises ever so slightly the mercury will touch M, and the current from the battery, Z, flowing through the wires, L and N, will pull down the armature, P, driving the cylinder, Q, down and shutting off the gas, except so much as may be necessary to keep the burners lighted.

This apparatus will maintain the temperature constant for days to half a degree; hence it is of use in accurate and long fractional distillations. It works with any kind or pressure of gas, and one cell will keep it going for months.—*Chem. News.*

THE PYROMETRIC TELESCOPE.

THE exact determination of the temperature of incandescent bodies is a problem that presents a great practical importance in a large number of industries founded upon the application of high temperatures. Such is the case, for example, in metallurgy, in furnaces for melting steel and for reheating ingots, in blast furnaces, in glass works, in porcelain manufactories, etc.

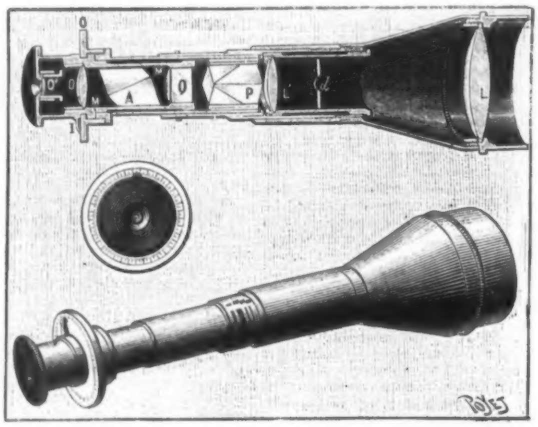


FIG. 1.—MESURE & NOUEL'S PYROMETRIC TELESCOPE.

The chemical reactions developed in these furnaces may, in fact, vary with the temperature, and this is even often the case with the physical properties. A piece of porcelain baked under proper conditions, at a given temperature, is incapable of supporting, without danger, a stronger heat, as this would cause cracks in the glazing, and, at a lower temperature, the reactions would be incomplete, and the enamel would be insufficiently fused, etc. So too, in steel furnaces, the degree of temperature is capable of completely modifying the direction of the oxidizing or reducing reaction, and seems in all cases to bring about a great modification in the proportion of the carbon combined or dissolved. The most recent theories, in fact, admit that such proportion is regulated by a sort of dissociation of tension variable with the temperature, etc. There evidently results from this an absolute necessity, for the success of the operations, of defining temperatures in a pretty precise manner, independent of all causes of error, in order to make it possible to reproduce with certainty, and under precisely identical conditions, the reaction that we have in view.

This can be done by observing the color of the incandescent objects. We know, in fact, that, in measure as the temperature rises, the color passes to bright red and gradually reaches the shades of yellow, red, orange, straw yellow, and finally a more or less dazzling white. There is a gamut of colors, well known to all, of which Pouillet, in his scale, has given the correspondence in degrees with the indications of the thermometer. It furnishes the characteristic of the variations in temperature; but from this point of view, a simple direct observation became insufficient, for it is impossible wholly to avoid errors that are due to the personal estimation of the observer. The eye cannot distinguish shades of color in an absolute manner, and scarcely judges of them except by comparison.

FIG. 2.—SMALLER FORM OF THE APPARATUS.

Dark red will appear like a bright red in a dark place, and, on the contrary, bright red may appear like a dark red in a strongly illuminated place. In a word, we have here an indisputable cause of error, well showing the necessity of having recourse to an instrument whose indications shall be indifferent to the external surroundings.

Such was the starting point of the numerous types of apparatus designed for estimating high temperatures through the measurement of a well defined phenomenon; some of them, pyrometers, based upon the use of a mass of clay whose shrinkage is measured, or of a current of water circulating under determinate conditions, whose rise in temperature is measured, etc., and others, photometers, based upon the use of optical processes for the measurement of the luminous intensity of incandescent bodies. The majority of such apparatus have unfortunately not given entirely satisfactory results.

The regulation of water pyrometers is one of the most delicate of operations, and photometers properly so called, like those of Mr. Crova or Mr. Trannin, are rather laboratory apparatus, which cannot be carried into manufactories.

The pyrometric telescope, on the contrary, furnishes a solution of the problem at once. It permits of estimating the temperature by a simple inspection, which gives the exact color of the incandescent piece.

It is a small, simple, accurate, and portable apparatus, thanks to which observers can, without error, define the temperature that they wish to obtain, and thus assure themselves that they are always operating under exactly identical conditions.

We have here one of the most important questions in every industry that makes use of high temperatures, and thus is explained the immediate success of the apparatus.

The pyrometric telescope is due to the two engineers of the St. Jacques works of Montlucon, belonging to the Chatillon-Commentry Company of Forges, whose large rolling mill we have already described,* and which has gained a special renown for itself in the world of metallurgy through the scientific interest of its work. This telescope is shown in Figs. 1 and 2 under two forms. The model shown in Fig. 2, which is the simpler type of the two, is scarcely more than 10 in. in length, and is easily portable; but the two types exhibit hardly any essential difference.

The apparatus is based upon the application of the phenomena of rotary polarization. It consists of two Nicol prisms, an analyzer, A, and another polarizer, P, whose principal sections make an angle of 90°, between which is interposed a disk of quartz, O. As we know, the ordinary luminous ray, on coming from the first prism, P, is polarized in a plane determined by the principal section of this polarizer, and is consequently entirely extinguished on traversing the second prism, A, whose principal section is at right angles with the first. The interposed quartz, which is at right angles with the axis, has the effect, on the other hand, of turning the plane of polarization, which becomes oblique upon the principal section of the analyzer, and can therefore traverse it without being completely extinguished. According to the well known law of Biot, the angle of deviation is proportional to the thickness of the quartz, and nearly inversely proportional to the square of the length of the wave. As the length of the latter depends upon the color, which itself depends upon the respective proportion of the simple rays of the light transmitted in the ordinary ray, it will be at once seen that the deviation observed will depend directly upon the color of the ordinary ray, and that if we have a means of measuring such deviation we shall at once be able therefrom to judge of the temperature according to the color of the incandescent body. To this effect, the analyzer is made movable, and is so mounted that it can revolve in the interior of the telescope so as to cause the principal section to make any angle whatever with the polarizer. An index, I, fixed in front of a marble graduated circle, C (Fig. 2), permits of ascertaining this deviation, the zero of which corresponds to complete extinction, the quartz being removed. If the incandescent body be observed while the analyzer is being slowly revolved, the light perceived is of a determinate tint which varies with the temperature, and this light disappears at a corresponding angle of rotation, and it is therefore this angle that is capable of serving to ascertain the temperature observed. Generally an endeavor is made to observe a determinate tint of easy distinction. It is found, in fact, that upon a very slight rotation of the analyzer, the tint perceived almost immediately changes from green to red, passing the while through a special tint—dirty lemon color, which lasts for but a moment, and which for this reason has received the special name of transition tint. It is to this tint that the measured angles are referred.

Besides these parts, the telescope, as shown in the section in Fig. 2, is provided with a lens, L, or a plain glass, *d*, forming an objective for collecting the ordinary rays and directing them upon the polarizer, and another lens, D, forming an eye piece, which receives the rays coming from the analyzer, and which is movable with the latter in its tube.

This telescope was constructed by Mr. Ducretet according to instructions furnished by Messrs. Nouel and Mesure, and has now been in use for more than a year in the Saint Jacques works, where the use of it has become familiar to all the under-engineers, and, by assuring the perfect identity of all the operations, it has much to do with the remarkable quality of the products obtained at this establishment.—*La Nature.*

* SCIENTIFIC AMERICAN of Feb. 9, 1889.

[Continued from SUPPLEMENT, No. 738, p. 11798.]

RABIES AND ITS PREVENTIVE TREATMENT.*

By ARMAND RUFFER, M.A., M.D.

DURING the period extending from November, 1885, to January, 1886, 2,164 human beings, bitten by animals proved to be rabid, were inoculated at M. Pasteur's Institute in Paris. Of these, thirty-two died (mortality 1·47 per cent.) On the other hand, 518 persons bitten by animals strongly suspected of rabies were submitted to the same treatment. Of these, three died (mortality 0·58 per cent.)

Notice that in the statistics are reckoned those even who died immediately after treatment, and before, in many cases at least, it could have had any beneficial effect.

The two following tables will show you better than any words of mine the result of M. Pasteur's treatment during the years 1887 and 1888:

TABLE I.—JANUARY 1 TO DECEMBER 31, 1887.

	A.	B.	C.
Number of persons inoculated......	1,778	1,501	277
Mortality, per cent., *a*............	1·34	1·52	0·78
" " *b*............	12·1	1·26	*nil.*

TABLE II.—JANUARY 1 TO DECEMBER 31, 1888.

	A.	B.	C.
Number of persons inoculated.....	1,626	1,371	255
Mortality, per cent., *a*............	1·16	1·31	0·39
" " *b*............	0·79	0 94	*nil.*

Explanation.—Column A in each table includes all the cases inoculated at the Pasteur Institute during the year. Column B includes only patients bitten by animals proved to be rabid at the time they inflicted the wound. (This corresponds to columns A and B in M. Pasteur's own table.) Column C gives the number of patients bitten by animals which, though presumably rabid, could not be proved to have been so.

Mortality *a*.—Total mortality, including patients dying during the progress of treatment. Mortality *b*.—Mortality after those dying during treatment have been excluded. *The lowest mortality in people bitten by rabid animals and not inoculated amounts to fifteen per cent. at least.*

As animals proved to be rabid, only those are counted in which the disease has been proved to be present by the test of inoculation, or by certificate from veterinary surgeons who have seen the animal alive or performed a *post mortem* on it.

You will notice that the mortality has been steadily decreasing each year as the methods of inoculation have improved, and I may tell you that this year the total mortality will probably not amount to 0·50 per cent.

If we remember that among these cases there are no less than 280 cases of face bites, and that the mortality among people bitten in the face and not inoculated amounted to 80 per cent., and if we also bear in mind that the lowest mortality among non-inoculated persons bitten in any part of the body amounts to 15 per cent., at least, we can form an opinion of the value of M. Pasteur's treatment.

But we medical men belong to a skeptical corporation, and for the following reason: When we read in one of our medical papers of a new mode of treatment or drug, we are well aware that at first this mode of treatment or remedy is always extremely successful. It cures everything (in the hands of its promoters at least), from polypus of the nose to gout in the big toe. Then, as the drug gets into the hands of other men, it is found that it is not the panacea which it was at first supposed to be, and it is but rarely that a new mode of treatment or a new remedy stands the test of time and criticism at the hands of independent observers.

Let us see now whether this applies to rabies also, for it would be an error to think that M. Pasteur is the only one who has applied this treatment. The experiments on which it is based have been repeated and proved to be correct by Mr. Horsley, and published in the report of the Royal Commission appointed at Sir Henry Roscoe's instigation. Antirabic institutes have been established in many parts, so that at the present time there are more than twenty of these establishments scattered all over the world. There are no less than seven of them in Russia alone.

When, in the month of August last, I was asked to read a paper before the British Medical Association on the same subject, I took care to write and obtain information as to the results obtained in these institutes. I give you here the various data as I was able to obtain them from official letters, without withholding one syllable of what might tell against M. Pasteur's treatment.

In the last six months of the year 1886, Bujwid inoculated 104 persons bitten by animals proved to be rabid, or which were most probably so. He lost one patient. He then tried a weaker treatment on 193 patients; eight of these died, among them being all those who had been bitten in the face. M. Bujwid then determined to give the intensive treatment a trial. He inoculated 370 persons bitten by animals undoubtedly rabid; four had been bitten in the face by wolves, thirty by rabid dogs in the face. All these 370

* A paper recently read before the Society of Arts, London. From the *Journal.*

people are alive now, more than one year after the last inoculation. M. Bujwid, in a private letter to me, dated July 29, 1889, tells me that he has inoculated 146 patients this year, of whom one has died. He also tells me that in his part of the country, and during his time of office at Warsaw, thirty-one persons who were not inoculated died of rabies, although, as he remarks, very few refuse to be inoculated nowadays after having been bitten.

At St. Petersburg 484 patients were inoculated from July 13, 1886, to September 13, 1888. The mortality is somewhat higher, being 2·68 per cent.

At Odessa, Dr. Gamaleia inoculated 324 persons in 1886 by the simple method, mortality 3·39 per cent. In 1887 he inoculated 345 persons by the intensive method, mortality 0·58 per cent.; while in 1888 the mortality among 364 persons amounted to 0·64 per cent. Dr. Bardach, the present director of the Institut Antirabic, of Odessa, has been kind enough to send me the following information: Twenty-six persons were inoculated after being bitten in the face by dogs proved to be rabid; of these, one child, seven years old, died. It is only fair to state that this unfortunate child arrived at Odessa fourteen days after the bite, and that it died on the nineteenth day after the wound was inflicted, that is, on the fifth day of treatment, before the latter could have produced any effect. All the patients who had recovered had been most fearfully bitten, one of them having had the face almost torn off by eight dreadful bites, and bitten eleven times in the hand besides; another showing thirteen deep wounds inflicted in the face by a rabid wolf. Of the 333 persons inoculated by Dr. Bardach, only two died (mortality 0·63 per cent.) Among the successful cases was one with thirty deep wounds, the results of bites from a wolf proved to be rabid. Among the 333 above mentioned were seven men who had never been bitten, but who insisted on being inoculated as a preventive measure (mortality *nil*).

At Moscow, Dr. Gwozdreff inoculated 107 persons in 1886 by the simple method (mortality 8·40 per cent.) In 1887, with the intensive treatment, the mortality was 1·27 per cent. among 280 inoculated persons. Dr. Jules Goldenach (Chef de l'Hopital Empereur Alexander III., Moscow), in a private letter, informs me that at Moscow, during the year 1888, 431 persons were inoculated according to M. Pasteur's method; 328 had been bitten by rabid domestic animals (mortality 1·82 per cent.), while of 70 bitten by wolves, 10 died (mortality 14·28 per cent.) Three of the deaths occurred in patients bitten in the face and head. One of them died only ten days after the treatment was finished, the other two dying during the progress of treatment—that is, before the preventive inoculations could have had any effect. Seven of the 11 deaths following wolf bites occurred in persons bitten in the face and head, while 8 of them took place either during the progress of treatment or within fourteen days after the last preventive inoculations—that is, 15, 19, 21, 24, 27, 28, 33, 44 days after the bite. Of the two others, one died 45 and the other 51 days after being bitten.

These Russian statistics are extremely interesting, for a great many of these patients were bitten by rabid wolves, and we know that after bites from these animals the mortality in non-inoculated persons varies between 60 and 64 per cent. Gamaleia, in 1888, collected 119 cases of persons bitten by wolves and inoculated according to M. Pasteur's methods. Of these, eight died (mortality 6·72 per cent.) M. Pasteur's treatment, therefore, saved 63 of these patients from a painful death, as the mortality after wolf bites in non-inoculated persons reaches 60 per cent.

In Italy, at Turin, Dr. Guido Bordoni Uffreduzzi has inoculated 531 persons, 486 patients having been bitten by animals undoubtedly rabid. Of these, ten died (mortality 1·88 per cent.) Of 43 persons bitten in the face and inoculated, he only lost one. At Milan, Dr. Baratieri has inoculated 335 persons up to November, 1888, and lost two.

Dr. Luigi di Blasi has kindly sent me the following account of his inoculations at Palermo. He has inoculated 343 persons since March, 1887, 68 being treated by the simple method (mortality 0·72 per cent.); 170 patients had been bitten by animals proved to be rabid. Of 21 patients bitten in the face one died, while of the 332 patients bitten in various parts of the body only three perished.

At Naples, Professor Cantani, assisted by Drs. Di Vestea and Zagari, has inoculated 347 persons, of whom 296 had been bitten by animals proved to be rabid (mortality 1·72 per cent.) It is noteworthy that during a period of seven months, Professor Cantani had to close his Antirabic Institute for want of funds, Mr. Pasteur's opponents being very powerful at Naples. During that period, however, nine persons died of rabies at Naples, and the Pasteur Institute had to be reopened.

At Constantinople 34 persons have been inoculated up to November, 1888, of whom not one has died.

At Havana, Dr. Tamayo has inoculated 170 persons (mortality 0·60 per cent.)

I have other facts, however, to bring forward, facts which have almost the value of a scientific experiment. A number of cases are to be found in the annals of the antirabic institutes, in which several persons having been bitten by the same animals, some have undergone M. Pasteur's treatment, and others, for various reasons, have not.

In the year 1887, 350 persons were bitten in Paris by rabid animals, 306 of them were inoculated by M. Pasteur, and three of them died, equaling 0·97 per cent.; 44 trusted to luck, and declined to be inoculated, and of these seven died—mortality, 15·9 per cent. These facts were elucidated by careful inquiries made by an independent medical man acting for the Prefect of Police, who is not in any way connected with the Pasteur Institute.

But there are other facts from other countries showing the same results. Only lately I have received a letter from Professor Babes, a well known bacteriologist, who has given me the following particulars as to the results of the inoculations practiced at the Antirabic Institute of Bucharest in Roumania. From the 1st of May to the 1st of August, 1889, 244 persons were inoculated at Bucharest after having been bitten by rabid domestic animals. The mortality among these persons is absolutely *nil*. On the other hand, 39 persons bitten by the same rabid animals declined to undergo treatment, and four of these, at least, have been certified as having died from rabies.

Thirty-four persons were badly bitten by wolves on the hand and were inoculated, and of these three died from rabies. On the other hand, every one of the persons who refused to undergo treatment after having been bitten by the same wolves as those before mentioned has died of rabies, as did 180 head of cattle bitten by the same animals.

Hogyes has published the following facts: During the period of time extending from the 1st of November, 1885, to the end of June, 1888, 532 human beings were officially registered in Hungary as having been bitten by rabid animals. Sixty-two of these persons were inoculated, and not a single one has died of rabies. On the other hand, of the 470 persons who were not inoculated, 44 at least have been certified as having died of rabies. I think it will be difficult even for the most skeptical of men to deny that M. Pasteur's treatment is often successful.

Many have stated that people have died from Pasteur's treatment who had never been bitten by rabid animals at all. I have made careful inquiries on that point, and what I can say is this, that the cases which have been published as occurring in France are absolutely and utterly false. For those published in Russia I cannot answer definitely, but what I can say is that I was unable to find any facts bearing out the truth of these statements in any of the official documents, and that all of them are based on mere hearsay evidence and daily newspaper reports.

M. Pasteur's assistants, the directors of the antirabic institutes, most of the servants in the laboratories, who must know, if anybody does, the *pros* and *cons* of the treatment, have most of them been inoculated, and no less than five of my personal friends have undergone the treatment. Do you believe these men would run the risk of being inoculated if they did not feel quite certain as to the result?

But you might say some of these patients have died from rabies, and who tells me that they did not die of the virus which M. Pasteur injected? In the first place, there is not a particle of evidence to show that such an event did really happen; but assume, for the sake of argument, that every one of these patients who died perished as the direct re ult of M. Pasteur's treatment. Even then, if I were bitten by a rabid animal, I would go and be inoculated. For, let us compare M. Pasteur's treatment to a surgical operation. If any one of us was suffering from a tumor, and a well known surgeon came to him and said: "I have operated on over 7,000 cases similar to yours, the operation is almost painless, and the mortality among my patients is one per cent.; but if you undergo no treatment, your chances of death increase to sixteen per cent." Is there one of us here to-night who would not at once place himself under the surgeon's hands, and undergo that operation, when by doing so his chances of life must increase from 84 to 99 per cent.?

My answer to your question is therefore this: "If ever I am bitten by a rabid dog, or an animal I supposed was rabid, my intention is to take the first train to Paris and be inoculated."

This paper has lasted much longer than I wished it to last, but my excuse is that I thought it would be well to give you a *resume* of the most important facts on which you can base an opinion. I will trespass just a few seconds more, and perhaps you will allow me to give in one sentence my opinion—for I do not presume to give advice—as to what should be done to stamp out the disease. Muzzle all the dogs, destroy all stray dogs, have a quarantine of six months for all imported dogs, and the disease will be stamped out of this country for ever. Meanwhile, before this has been effected, if you are bitten by a rabid animal, do not trust to luck or cauterization, but go and be inoculated at once.

DISCUSSION.

Dr. J. G. Adami (Christ's College, Cambridge) said he appeared there that evening as the "awful example." During the present year there had been a remarkable epidemic of rabies among the deer in the Marquis of Bristol's park at Ickworth, and while investigating the malady, in making a *post-mortem* examination, he unfortunately cut himself. At the time, not knowing what the disease was, he thought very little of it, and simply cauterized the wound, but a few days later, when he obtained convincing evidence that the deer were dying rapidly of rabies, and when he also found that the knife with which he had cut himself had been used to dissect the brain and spinal cord of the deer, he became apprehensive, and rushed off to Paris. He found the Pasteur Institute a large, handsome, and cheerful building in the suburbs, containing a large library and many other rooms besides those used in the antirabic treatment. The course was this: The patient was first shown into a large waiting room, very well appointed, and much more cheerful than any outpatient's room he had seen in England. From this room he passed into a smaller one like an office, round which were placed the *dossiers* of previous patients, and on the table was a large book in which all particulars were entered, two pages being allotted to each patient, giving all the details of the bite, the animal, its condition, etc., and the treatment. Not having looked up the subject previously, he was in some doubt before going to Paris as to the value of M. Pasteur's statistics, but immediately on his arrival every information was afforded him; he had free access to the laboratory and to all the books, and after a careful inspection he came to the conclusion that every care was taken that nothing was placed in the statistics but what was absolutely correct, and that everything was recorded, whether in favor of the treatment or against it. He need not describe the preparation of the virus, but might say that each day on entering the operating room you found a number of persons of various ages and nationalities, and on one occasion he found himself between a Jesuit *curé* and an Arab sheik; and there were adults and almost babies in arms, and all formed *queue* in the regular French fashion. The operation was performed on one patient after another with a small hypodermic syringe, the virus used at first being very weak and afterward gradually increased in strength, about 30 minims being injected in the walls of the abdomen. To some few persons this operation seemed very painful, and one patient spoke of it as the fiery ordeal, but, as a rule, there was no pain worth mentioning, and several English children who were there, on the recommendation of himself and a friend who was with him, never showed either fear or pain, and many of the French children tried to follow their example. Five minutes afterward there was no discomfort whatever from the puncture. While there he saw every detail, and could confirm what Dr. Ruffer had said about the marvelous precision which governed every step. There were only two slight objections, perhaps, from an English point of view; one the semi-public character of the proceedings, and the other that there was practically no one there that could speak English sufficiently well to be of much use to an uneducated person. Both these objections would be removed if a similar institution were established in England. Shortly after the completion of the treatment, he experienced some rather anomalous symptoms, but even now he could not say whether they were subjective merely, or were of the nature of rabies, probably the former. If they were, he was saved an immense deal of suffering and anxiety from the security he felt, and if they were the latter he was still more fortunate in having escaped so deadly a disease.

Prof. Ray Lankester, F.R.S., expressed his great satisfaction with the paper, which was a most able exposition of the whole case, and contained the most complete statistics bearing on the result of Pasteur's treatment. He could personally confirm the account given of the great completeness of the institution, and of the great care devoted to the preparation of the virus used in the treatment. He should be glad if the meeting could in some way express an opinion with regard to the two questions which had been raised as to muzzling, and the general feeling as to this method of prevention. It was desirable in a country surrounded by the sea to get rid altogether of a terrible disease like hydrophobia, and there was no reason why they should not. It was simply their own folly in assisting and nourishing it in their own midst. They had only to muzzle all dogs, and impose a sufficient quarantine, to get rid of it entirely. There was no reason to believe that at the present time this disease had ever appeared *de novo*. It was probably of a prehistoric origin—handed through various carnivorous animals, and from time to time affecting the dogs of civilized races through the attacks of wolves. In this island, there was no reason why it should exist, any more than wolves, which were got rid of in the reign of Edward III. It was not sufficient that dogs were muzzled in great towns, because after a time, when the immediate cause of disease was got rid of, London was again affected by the inroads of unmuzzled dogs from the wild country. The system ought to be universal, and public authorities ought to understand that this was a serious thing which should be carried out. Until within the last year or so it had not been understood by those having the reins of government that the muzzling of dogs would be effective, but there was no doubt about it now. As to Pasteur's treatment, he thought even the more skeptical must be convinced by its effects. During the first year the results were promising, but it was quite justifiable for any one to withhold their judgment for a time. But there had now been four years' experience, and every year far better results had been obtained. The system had been tried, not only by Pasteur himself, but by others in various parts of Europe, and the results entirely confirmed those obtained by Pasteur himself, so that there could be no doubt of the great debt of gratitude which the whole civilized world owed to M. Pasteur.

Dr. G. Fleming said he had the honor some ten years since of reading a paper on the contagious diseases of animals, and the means of suppressing them, and since that time one fell malady, the foot and mouth disease, had been practically eradicated.

He then referred to rabies as a malady which caused great loss, and few had any conception of the injury it inflicted on the animal creation. The loss of property was very great in the shape of cattle, sheep, horses, and dogs who were killed by it, and in France the loss among domestic animals had been estimated at £40,000.

It was high time, therefore, that attention should be directed to its prevention. No one had a greater reverence for Pasteur than he had; he was a member of the committee to which the chairman had referred, and was glad to find that the conclusions then arrived at had been amply supported by further experience, and it was very satisfactory to find that the value of Pasteur's work was being generally recognized. The chief causes of the continuance of this disease in England were sentiment and ignorance of the nature of the disease.

When he published a work upon it, sixteen years ago, he was rather inclined to believe in the spontaneity of the malady, his information not being then so full as it became immediately afterward, and he had cases under his observation which he could not trace to any source of contagion.

His doubts were shared by eminent veterinarians on the Continent, notably by his deceased friend M. Bouley; but shortly afterward he had reason to change his opinion, and he now firmly believed that the disease never arose spontaneously.

The best evidence of that was that in the island of Bourbon it had been stamped out for more than half a century, though in the island of Mauritius it raged with great virulence from time to time, and was never entirely absent.

It was nonsense to say that muzzling dogs would send them mad; you might as well say that wearing a high collar would give a man the cholera.

Six or seven years ago he was consulted by the agent-general for New South Wales as to the best means of preventing the introduction of the disease into the colony, and he advised a strict quarantine of six months. Probably it would have been safer to name a longer period, but so far the measure had been effective in preventing the introduction of rabies, and he did not know that any stronger evidence could be given of the non spontaneity of the disease than that afforded by the Australian colonies.

He maintained that the use of the muzzle was the chief repressive measure. Wherever the muzzle had been employed as it should be, rabies had been either very much diminished or altogether extinguished. The objections to it were frivolous in the extreme, and he could not see why dogs should be exempted from a slight restriction of that kind, when horses had to bear shoeing and to submit to a bit and a bearing rein.

Any one who had ever seen a human being or an animal die of rabies would advocate this measure at once. A properly constructed muzzle was no more

hardship to a dog than a bit was to a horse. It not only prevented the dog biting, but was an indication that he had an owner, and was cared for; it was said that the stray dogs did the mischief, but how could you tell which were stray dogs without some visible indication? and there was no better indication than the muzzle. But muzzling, to be effective, must be universally applied, and for a certain period.

A rabid dog would run fifty or sixty miles before he was exhausted, which showed the futility of applying the muzzling order within a limited radius. If universally applied, the disease would soon be extinguished. He knew of no malady which could be more easily stamped out, for it was only communicated by biting, and if you prevented animals from biting, you would put an end to it.

Dr. Charles Drysdale desired to indorse every word in the paper, and particularly the statement that by muzzling dogs rabies might be got rid of. Throughout Germany they had no Pasteur Institute, because there was no rabies to treat.

Dr. Ruffer, it would be noticed, had made no allusion to Sweden or Norway, because there they had no rabies; and two years ago Professor Virchow said he thoroughly agreed with Pasteur's splendid discovery, but it was not required in Germany, because there they muzzled the dogs.

He was a thorough believer in Pasteur's experiments, having attended his clinique for the last four years, and was thoroughly convinced by the way in which he proved his case. He treated forty dogs and inoculated them preventively; then he injected over the *dura mater* a certain portion of rabid virus, and the dogs remained perfectly free from disease. After that he gave in his adhesion at once, the experiment being as conclusive as Jenner's with regard to vaccination.

The chairman said there was one point which struck him very much on visiting the Pasteur Institute. It might have been feared that the introduction of an emulsion made from the spinal cords of rabbits would do mischief by introducing putrid matter likely to produce *septicæmia* unless the most extreme care was taken, and this naturally struck one as a weak point in the system. But when he visited the institute, he was delighted to find that the most extraordinary antiseptic precautions were taken, and not only so, but the brain and spinal cord which were to be used were first put for some days into a sterilized *bouillon*, to ascertain whether they had any microbes adhering to them, and only if they proved perfectly free were they used. But, as he was informed, practically they never had to throw one away.

He believed the more any one went into the subject with a knowledge of it, the more he would be convinced of the absolute trustworthiness of the statistics. It struck him as an admirable instance of Pasteur's open-mindedness that though he had spent so many years in elaborating his preventive system, he at once said:

"In England you are most favorably situated for getting rid of the disease, in consequence of your insulated position; you may make my method absolutely superfluous. Germany had to muzzle in perpetuity, being surrounded by nations who did not muzzle; but in England it would only be necessary to have a certain period—not very long—of universal muzzling, and then a rigid quarantine afterward."

If this were the real truth, the legislature ought to be impressed with that view, and the thing ought to be done as Sir Henry Roscoe said.

Dr. Ruffer, in reply to Mr. Martin Wood, said the objection was that one mad dog must have existed some time, and if the disease never arose spontaneously, they must assume he came out of Noah's ark. That was true enough, but then they must assume that every infectious disease came out of the ark, and, as there were few people in it, they must have been pretty bad. With regard to the statistics, he had carefully excluded from column B all cases except those in which the animal inflicting the bite had been proved to be mad. In the third column there might be some cases of fright, and he knew of two cases in which it turned out that the dog was not mad.

He had had cases in England in which people had come to him, and on inquiry had seen no reason to suppose they had been bitten by a mad dog, and he had then advised them to go home. All the cases were carefully investigated. He had heard of people being cured after showing the first symptoms of hydrophobia, and had read of such cases, but he had been unable to satisfy himself that a patient who had ever shown the first typical symptoms had ever got well.

The Buisson treatment had been tried in several places, in Leeds for instance, where Dr. Eddison told him he had tried it once, but would never do so again, and that he had to take the patient out as quickly as he could.

This method had been often tried, and had always proved, when applied by competent men, perfectly useless as far as he knew. In his opinion, if all dogs were muzzled, rabies would disappear. The really dangerous stage was before the dog showed any marked symptoms, and during that time, if he were muzzled, it might prevent many dogs being bitten.

Whenever muzzling had been efficiently carried out, rabies had disappeared, and that was enough for practical purposes. He would give particulars of five cases which he had come across in the records of the Pasteur Institute:

"1. Cabout, Henry, a butcher's boy, was bitten on April 22, 1888, but did not undergo the anti-rabic treatment, and died in September, 1888. The same dog bit another person, Louis Pavie by name. The latter was inoculated from April 24 to May 11, and is now in perfect health.

"2. M. Delaunay, a modern Hercules, an acrobat by profession, whose chapped hands were simply licked by his rabid dog. On the same day a young man, Leon Schan, of the Paris Belleville, was bitten rather badly by the same dog. Schan underwent the preventive treatment from March 29 to April 7, 1889, and is still in good health. Delaunay died of furious rabies in the month of May last. The same dog bit other dogs, and it is a fact that one of the latter became rabid on April 12, and bit two persons, Mrs. Lacasse and Mr. Fanconnier. They were inoculated from April 12 to May 2, and are now quite well.

"3. Eight persons belonging to the France family, the father, mother, and six children, were bitten at St. Martin des Olmes, in the Puy de Dome. One of the children died of rabies on January 1. The seven others at once left to be inoculated, and are quite well now. Three oxen, two dogs, and one cat bitten by the same dog, died of rabies in the second month after being bitten.

"4. On June 1 and 2, 1889, eight persons hailing from Vaucluse were bitten by the same dog. Six of them submitted themselves to the anti-rabic treatment, and are now quite well. Two declined to be inoculated, and both died of rabies, one on July 1 and the other on July 2.

"5. Pierre Butte and his wife were licked on open wounds. The wife declined to be inoculated, and died of rabies. Butte, on the other hand, was inoculated and is now quite well."

VOICE LOZENGE.

Dr. Hinkle recommends the following formula as the best for a "voice lozenge" in the ordinary hoarseness of singers and speakers. A small piece should be allowed to dissolve in the mouth just before using the voice:

Cubebs	1/2	grain.
Benzoic acid	1/3	"
Hydrochlorate of cocaine	1/12	"
Powdered tragacanth	1/4	"
Extract of licorice	5	grains.
Sugar	13	"
Eucalyptol	1/4	minim.
Oil of anise	1/10	"
Black currant paste, enough to make	20	grains.

—*Chemist and Druggist.*

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